Energy Citizenship and Energy Communities
for a Clean-Energy Transition

D5.4
Evaluation of the effectiveness of tools

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Abstract

This deliverable reports on the evaluation of two tools aimed at enhancing energy citizenship and energy communities. Drawing from insights from previous work packages and co-creation workshops, the first tool is a handbook for constructing user-friendly energy community information websites, modeled after the Austrian coordination offices for energy communities' website. The second tool is a prototype forum dedicated to energy communities, addressing the need for networking. Two studies were conducted to assess these tools. The first study, focusing on the website tool, involved a representative sample in Austria (n = 436). Results indicated that engagement with the website significantly increased participants' perceived knowledge about energy communities and their intention to establish or join one. Furthermore, we found that the effect of website engagement on energy citizenship is mediated by knowledge and intention to join or establish an energy community. The second study evaluated the energy community forum mockup through an online survey (n = 32). Overall, participants found the forum easy to use, with high usability ratings. Improvement suggestions included visual enhancements and additional features. These findings suggest that both tools hold promise in promoting energy citizenship and community engagement.

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List of Abbreviations

ZSI	Zentrum für Soziale Innovation GmbH
Uni Graz	Universität Graz
ULEI	Universität Leipzig
WUEB	Uniwersytet Ekonomiczny we Wrocławiu
UG	Rijksuniversiteit Groningen
ICLEI	ICLEI European Secretariat GmbH
GEN Europe	Global Ecovillage Network of Europe E.V.
HCWS	Spółdzielnia Mieszkaniowa Wrocław-Południe
Prusice	Gmina Prusice
Scalenghe	Commune di Scalenghe
TURE NIRVANE	Ture Nirvane Societa' Cooperativa Sociale di Comunita'
ABM	Arterra Bizimodu
Buurkracht	Buurkracht Projecten B.V.
GRO	Groningen municipality

1 Evaluation of the effectiveness of tools

1.1 Introduction

WP5 was dedicated to the development of tools that enhance energy citizenship and energy communities by addressing barriers and promoting facilitation. We developed two tool prototypes by drawing insights from the outcomes of WPs 2, 3, and 4, coupled with the experiences from energy communities across four European regions. As emphasized in WP2, active participation in energy communities stands as a prominent manifestation of energy citizenship (D2.1). Consequently, we put a strong focus on tools that can support energy communities.

To develop the tools, the EC² project organized co-creation workshops across European regions (Italy, the Netherlands, Poland, and Spain), involving stakeholders from the energy sector, energy community members, and citizens. During these workshops, ideas for tools capable of overcoming barriers or reinforcing facilitators for energy communities and energy citizenship emerged. The discussions during the co-creation workshops highlighted the importance of easily understandable information and opportunities for networking (see D5.2).

Upon comparing these insights with an existing tools overview compiled earlier in the project (D5.1), it became evident that the Austrian coordination office for energy communities' website (energiegemeinschaften.gv.at) already incorporated many features requested during the co-creation workshops. Consequently, our focus shifted to this website, with the decision to create a handbook based on its structure, tailored to aid ministries and administrations in constructing user-friendly websites that support energy communities. The resulting websites aim to provide users with an intuitive interface, valuable information, and resources, facilitating their active involvement in existing or newly formed energy communities. The handbook aims to provide a comprehensive overview that can be translated and adapted for different countries, meeting the most frequently voiced demand from the co-creation workshops: the need for easily accessible and comprehensive information.

Despite the Austrian website's alignment with workshop expectations, it lacked a crucial element repeatedly emphasized in the co-creation sessions—a networking feature. To address this gap, our second tool takes the form of a prototype forum dedicated to energy communities. This platform will allow users to pose questions, provide answers to other users, and establish connections, fulfilling the communal desire for a space to engage, share insights, and foster collaboration within and across energy communities and interested people.

In the end, through a combination of extensive desk research on existing energy citizenship and energy community tools, along with the mentioned two rounds of co-creation workshops, two tool prototypes were developed (see D5.3), i.e., a handbook for constructing user-friendly energy community information websites (tool 1) and a networking forum (tool 2).

1.2 Website (Tool 1), Experimental study, representative sample Austria

The handbook should aid ministries, and public administrations to construct user-friendly energy community information websites. Such websites then have the potential to enhance their user's energy citizenship and to support energy communities. Therefore, the effectiveness of our tool – the handbook - depends heavily on the effectiveness of such a website. Only if the website is effective, the handbook could be a useful tool. Because the handbook is based on the Austrian coordination office for energy communities' website (energiegemeinschaften.gv.at), we decided to determine this website's impact on users' perceived knowledge of energy communities, and their willingness and perceived capability to found or join energy communities as a prerequisite of the effectiveness of tool 1. The website provides clear information on energy communities—such as a step-by-step guide, details on founding, and a benefit calculation tool—all features mentioned in the co-creation workshops, involving stakeholders from the energy sector, energy community members, and citizens. Consequently, we hypothesized that participants engaging with the website of the Austrian coordination office would exhibit higher knowledge about energy communities (H1a) and a greater intention to establish or join an energy community (H1b) compared to the control group with no website engagement.

To test these hypotheses, we set up an online experiment in which participants were randomly assigned to either the control group, which received a brief summary on energy communities, or the experimental group, tasked with engaging with the website (the Austrian coordination office for energy communities' website). Afterwards, the experimental group received questions focused on their perceptions of the website, preferred aspects, and suggestions for improvement. In the end, both the experimental and the control group answered questions, covering energy citizenship (individual and collective), collective agency and identification, knowledge about energy communities, and intentions to join or establish an energy community.

1.2.1 Method

1.2.1.1 Sample and Design

The data were collected using the online survey tool Lime Survey and distributed to potential participants via an online panel agency. Representativity of the sample was assured via defining subgroup quotas regarding gender, age, education, and federal state. The study was preregistered at the OSF (https://osf.io/72a8z). Using G*Power, a power analysis was

conducted to calculate the required sample size for an independent samples t-test (main hypothesis), assuming a small (d = 0.2) to medium effect (d = 0.5) with a power of .80 and a significance level of α =.05. The results revealed a required sample size between n = 128 (d = 0.5) to n = 788 (d = 0.2).

In total, n = 632 people finished the online survey. Participants in the experimental group that have not clicked on or stayed inactive after initially clicking on the website (which was observed via tracking data), were excluded from further analysis, as substantially engaging with the website was considered a necessary precondition to answer subsequent questions. For substantial engagement we defined an absolute minimum criterium of time > 0 spent on the website. Consequently, n = 244 participants were excluded based on this reason; the remaining sample consists of n = 388 participants that successfully completed both the survey as well as the evaluation of the website. To be able to better interpret the effect of the website, we separately recruited a group of experts (n = 48) that already have gained a certain expertise in the area of energy communities. Having established or joined an energy community, professionally dealing with energy communities, or having gathered a considerable amount of information, qualified one as being an expert. The experts received the same questions as the control group. The final sample including the group of experts consists of n = 436 participants, with 187 female, 247 male and two diverse people. Among these participants, 20% were between 18 and 29 years old, 22% between 30 and 39, 22% between 40 and 49, and 36% were above 50 years old. Regarding education level, 306 (65%) did have a university entrance diploma, while 160 (35%) had not. The median household income level was 41,000 to 60,000 euros gross per year.

1.2.1.2 Procedure and experimental conditions

When clicking on the survey link, participants were first asked to answer some questions regarding demographic variables. Afterwards they were randomly assigned to one of two experimental conditions. While the control group received only a short summary on energy communities, the experimental group was asked to engage with the website on energy communities. After receiving the link to the website, participants had the possibility to freely search the website as long as they wished for. However, to prevent participants from immediately returning to the survey without substantially engaging with the website, we announced that there will be questions regarding the website afterwards. These questions concerned their perception of the website, what aspects of it they liked and how it could be improved. The remaining questionnaire was the same for both experimental groups. Participants were asked to fill in questions about energy citizenship (individual and collective), collective agency and identification and their knowledge about energy communities as well as their intention to join or establish an energy community. We also have tracking data from the website available. However, apart from the total time spent on the website, the analysis of this data is not part of the current deliverable.

1.2.1.3 Measures

As the dependent variables we measured the amount of *perceived knowledge about energy communities*, the *intention to establish or join an energy community, individual and collective energy citizenship,* and *collective agency and identification*.

Knowledge on energy communities (Cronbach's Alpha = .916) was measured using 7 items. Items were answered on a 7-point Likert scale, ranging from 0 (not at all) to 7 (completely). Items were directed to perceived knowledge about energy communities, e.g., "I feel well informed about energy communities.", but also to a more general interest in the topic of energy communities, e.g., "I am interested in learning more about the topic of energy communities."

Intentions to establish or join an energy community (Cronbach's Alpha =. 892) were measured using 4 items, answered on a 7-points rating scale, ranging from 0 (not at all) to 7 (completely). Example items were "I want to join a local energy community.", or "I am interested to support a local energy community.".

Individual (Cronbach's' Alpha = .908) *and collective energy citizenship* (Cronbach's' Alpha = .927) were measured each with a subscale consisting of nine items. Instead of using the two subscales separately, an overall score can be calculated as well (Cronbach's Alpha = .951). All items were answered on a 7-points Likert scale, ranging from 0 (not at all) to 7 (completely). Items were the same for both subscales. However, while items at the individual level were answered from the perspective of the individual, items in the collective level energy citizenship subscale were answered from the perspective of the member of a certain group (which is for this study Austrian citizens). Example items were "I consider affordable sustainable energy to be an important right." (individual level) and " We Austrian citizens, consider it an important right to be informed about the energy efficiency of various products." (collective level).

Finally, we measured *collective agency and identification as an Austrian citizen* (Cronbach's' Alpha = .901) using eight items. Again, items were answered on a 7-points Likert scale, ranging from 0 (not at all) to 7 (completely). Example items were "Austrian citizens are capable of acting.", or " Austrian citizens are able to promote a just and sustainable energy transition.".

Table 1 displays descriptive statistics, Cronbach's Alpha, and correlations among the variables.

Table 1. *Descriptive statistics, reliability, and correlations*

		M	SD	1.	2.	3.	4.	5.
1.	Knowledge	4.57	1.51					
2.	Intention	4.59	1.54	.779**				
3.	Energy Citizenship ind.	5.10	1.23	.678**	.706**			
4.	Energy Citizenship coll.	5.22	1.22	.520**	.549**	.803**		
5.	Energy Citizenship (combined)	5.16	1.16	.632**	.662**	.950**	.949**	
6.	Agency & Identification	4.58	1.21	.466**	.451**	.527**	.596**	.591**

Note: Correlations marked with ** are significant at level p < .01

In the experimental group, we also measured how participants perceived the website using three items, answered on a 7-point rating scale, ranging from 0 (not at all) to 7 (completely). Items were "How appealing do you find the website design?", "How comprehensive do you perceive the information on the website?", and "Do you perceive the website to have a clear structure?". The website was perceived rather positive by the participants in the experimental group, as indicated by the scores for comprehensibility of the information (*M* = 5.51, *SD* = 1.32), appealing design (*M* = 5.35, *SD* = 1.38), as well as clear structure (*M* =5.40, *SD* = 1.34).

1.2.2 Results

1.2.2.1 Effects of experimental manipulation

We hypothesized that knowledge about energy communities (H1a) und intention to establish or join an energy community (H1b) is higher in the experimental group after engaging with an energy community website (EG; *n* = 176), compared to the control group (CG; *n* = 212), which was not offered an energy community website. As mentioned above, we recruited a group of experts (EX, *n* = 48) that also did not engage with the energy community website but already had a certain expertise on the topic, to take part in the study in addition to the two experimental groups. The expert group was analyzed as another condition within the paradigm. However, as this third group was not initially preregistered, we report results concerning the comparisons with the expert group as exploratory.

To test the hypothesis, the data was subjected to two separate One-Way ANOVAs with experimental conditions (EG, CG, EX) as the independent variable and knowledge about energy communities as well as intention to establish or join an energy community as the dependent variables. Descriptive statistics and the results of the ANOVAs are displayed in Table 2.

Table 2. *Means and standard deviations per condition.*

	Control group (n = 212)		Experimental group (n = 176)		Expert group (n = 48)		F	p	η^2
DV	*M*	*SD*	*M*	*SD*	*M*	*SD*			
Knowledge	3.93[a]	1.35	4.81[b]	1.29	6.56[c]	0.71	88.17	<.001	.352
Intention	4.20[a]	1.47	4.57[b]	1.44	6.40[c]	0.78	48.32	<.001	.243
Energy Citizenship ind.	4.81[a]	1.23	5.12[b]	1.15	6.29[c]	0.64	31.96	<.001	.186
Energy Citizenship coll.	5.05[a]	1.24	5.29[ab]	1.17	5.74[b]	1.15	7.04	<.001	.067
Energy Citizenship (combined)	4.93[a]	1.19	5.21[ab]	1.10	6.01[c]	0.80	18.55	<.001	.129
Agency & Identification	4.45[a]	1.20	4.76[b]	1.27	4.53[ab]	0.93	3.09	.042	.041

Note: Different superscript letters indicate significant pairwise comparisons at level $p < .05$.

The ANOVAs on both knowledge about energy communities and intention to join or establish an energy community, revealed a significant effect of experimental group. Pairwise comparisons using Bonferroni correction suggest that in line with what was expected both knowledge (H1a) and intention (H1b) are higher in the experimental group than in the control group. Experts are showing the highest scores on both measures.

Next, we checked whether individual and collective energy citizenship as well as agency and identification differed among experimental groups as well. The analysis revealed a significant effect of experimental group for all three measures (see Table 2). Pairwise comparisons using Bonferroni correction suggest that individual energy citizenship is lowest in the control group compared to the experimental and expert group, with people in the expert group showing the highest level. Collective energy citizenship was significantly lower in the control group compared to the expert group, while the experimental group did not differ from either control nor expert group. For individual and collective energy citizenship combined, we found the same pattern of results as for individual citizenship. Energy citizenship is lowest in the control group compared to the experimental and expert group, with people in the expert group showing the highest level. Finally, individuals in the experimental group showed higher levels of agency and identification compared to the control group; expert's agency and identification lay in between and did not differ significantly from each control and experimental group.

Taken together these results indicate that engagement with the Austrian coordination office for energy communities' website indeed increases perceived knowledge about energy communities and people's intentions to establish or join an energy community. They also provide first evidence that the website enhances people's individual energy citizenship and their collective agency and identification as Austrian citizens. However, the short engagement with the website was not enough to bring the users on a level with the experts concerning knowledge, intention and individual energy citizenship.

As displayed in Table 1, energy citizenship (individual and collective) and agency and identification are positively related to knowledge about and intention to join or establish an energy community. We were interested in whether website engagement (experimental condition) predict knowledge about and intention to join or establish an energy community even if we control for these individual factors as well as for socio-demographic variables. Before calculating a multiple regression analysis, model assumptions (linearity, homoscedasticity, normality, multicollinearity) were checked and revealed no problematic issues. We calculated two separate multiple regression analyses with knowledge about and intention to join or establish an energy community as the two criterion variables and the dummy coded experimental conditions as the predictor variables, including energy citizenship (individual and collective level combined), agency and identification, and the sociodemographic data, sex, education, age, and income level as additional predictors in the model.

For the knowledge about energy communities, the overall regression model was significant, $F(8, 433) = 69.33$, $p < .001$, $R^{2corr.} = .558$. Among the predictors entered into the model, energy citizenship, agency and identification, as well as being in either the experimental or the expert group, significantly and positively predicted knowledge about energy communities. There were no significant effects of sociodemographic variables. Regression coefficients are displayed in Table 3.

Table 3. *Multiple regression analysis on knowledge about energy communities.*

	B	*SE*	β	*T*	*p*	95% *CI*	
						LL	*UL*
(Constant)	.248	.269		.922	.357	-.281	.778
Sex (male)	.062	.099	.021	.631	.528	-.132	.257
Education	-.127	.111	-.041	-1.141	.254	-.345	.092
Age	-.020	.043	-.015	-.466	.641	-.105	.065
Income	.035	.040	.030	.881	.379	-.043	.113
Energy Citizenship	.504	.056	.389	9.038	<.001	.395	.614
Agency & Identification	.262	.051	.209	5.143	<.001	.162	.363
Exp. group (CG vs. EG)	.647	.103	.213	6.275	<.001	.444	.849
Exp. group (CG vs. EX)	2.074	.182	.436	11.410	<.001	1.717	2.431

Note. *B* = unstandardized regression coefficient; *SE* = standard error; β = *standardized regression coefficient; CI* = confidence interval; *LL* = lower limit; *UL* = upper limit.

For the intention to join or establish an energy community, the overall regression model was significant, $F(8, 433) = 61.87$, $p < .001$, $R^{2corr.} = .529$. Among the predictors entered into the model, energy citizenship, agency and identification and being in the expert group significantly and positively predicted knowledge about energy communities. Among the sociodemographic variables, being male, having a higher income, and being younger in age significantly predicted the intention to join or establish an energy community. In this model, being in the experimental versus the control group did not explain unique variance in intention. Regression coefficients are displayed in Table 4.

Table 4. *Multiple regression analysis on intention to join or establish an energy community.*

	B	*SE*	β	*T*	*p*	95% *CI*	
						LL	*UL*
(Constant)	.068	.285		.238	.812	-.493	.629
Sex (male)	.223	.105	.072	2.129	.034	.017	.429
Education	-.080	.118	-.025	-.676	.500	-.311	.152
Age	-.172	.046	-.128	-3.769	<.001	-.261	-.082
Income	.107	.042	.089	2.544	.011	.024	.190
Energy Citizenship	.679	.059	.510	11.486	<.001	.563	.796
Agency & Identification	.199	.054	.154	3.678	<.001	.093	.305
Exp. group (CG vs. EG)	.079	.109	.025	.722	.471	-.136	.293
Exp. group (CG vs. EX)	1.326	.193	.272	6.887	<.001	.948	1.705

Note. *B* = unstandardized regression coefficient; *SE* = standard error; β = *standardized regression coefficient; CI* = confidence interval; *LL* = lower limit; *UL* = upper limit.

1.2.2.2 Exploratory analysis

We wanted to explore whether engagement with the website does not only increase perceived knowledge and intention, but whether knowledge and intention then predict energy citizenship. In other words, whether the effect of website engagement on energy citizenship is mediated by (a) knowledge and/or (b) intention to join or establish an energy community. Therefore, two simple mediation analyses were performed using SPSS Macro Process, Version 4.0 (Model 4; Hayes, 2021). To analyze the effect of experimental group, dummy variables for each comparison among experimental groups were added to each model: X1 for the comparison between control and experimental group, X2 for the comparison between control group an expert group, and X3 for the comparison between experimental and expert group (X3). Mediation analysis were performed with 95% bias-corrected confidence intervals based on 5000 bootstrapped samples.

(a) Knowledge about energy communities as mediator. An effect of group on energy citizenship was observed for all three dummy categories, X1 (control group vs. experimental group): b = 0.272, t(433) = 2.331, p = .020, 95% CI [0.043; 0.502], X2 (control group vs. expert group): b = 1.082, t(433) = 7.604, p < .001, 95% CI [0.802; 1.362], and X3 (comparison between experimental vs. expert group): b = 0.810, t(433) = 5.660, p < .001, 95% CI [0.528; 1.09]. This is consistent with the results of the ANOVA (see Table 2), but the non-significant pairwise comparison between control and experimental group (*p* = .052) reaches significance in this analysis.

After entering the mediator into the model, group membership predicted knowledge significantly; X1: b = 0.875, t(433) = 6.479, p < .001, X2: b = 2.628, t(433) = 18.904, p < .001, X3: b = 1.753, t(433) = 12.345, p < .001 (see also Table 2), which in turn predicted energy citizenship significantly, b = 0.522, t(432) = 14.111, p < .001. Being in either the experimental or the expert group is associated with more knowledge about energy communities compared to the control group, with experts having even higher knowledge compared to participants in the experimental group. More knowledge in turn is associated with higher energy citizenship. Finally, we found that the relationship between group and energy citizenship is no longer significant when the mediator is considered. This holds for all three comparisons among the groups, X1: b = -0.185, t(432) = -1.930, p = .054, X2: b = -0.291, t(432) = -1.845, p = .066, and X3: b = -0.106, t(432) = -0,745, p = .457. The relative indirect effect supports the assumption that the relationship between group and energy citizenship is mediated by knowledge, as zero is not involved in the 95% confidence intervals, X1: b = 0.458, SE = 0.135, 95% CI [0.615; 1.143], X2: b = 2.628, SE = 0.138, 95% CI [2.356; 2.894], and X3: b = 0.916, SE = 0.101, 95% CI [0.722; 1.120]. A Sobel test has been carried out to test the significance of the mediation. It revealed significant results for all three comparisons among groups, Sobel X1 = 5.876, p < .001, Sobel X2 = 11.297, p < .001, Sobel X3 = 9.187, p < .001. The mediation model is depicted in Figure 1.

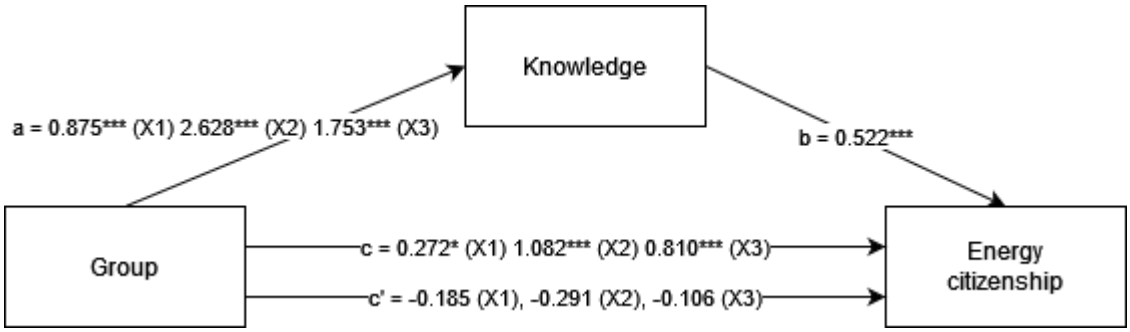

Figure 1. *Standardized regression coefficients for the relationship between experimental group and energy citizenship as mediated by knowledge. Note. X1: experimental vs. control group; X2: expert vs. control group; X3: expert vs. experimental group; * p < .05; ** p < .01; ***p < .001.*

(b) Intention to join or establish an energy community as mediator. After entering this mediator into the model, group membership predicted the intention to join or establish an energy community significantly; X1: b = 0.365, t(433) = 2.457, p = .014, 95% CI [0.073; 0.658]; X2: b = 2.198, t(433) = 14.449, p < .001, 95% CI [1.899; 2.497] X3: b = 1.833, t(433) = 11.653, p < .001, 95% CI [1.524; 2.142], which in turn predicted energy citizenship significantly, b = 0.500, t(432) = 15.789, p < .001., 95% CI [0.437; 0.562]. Being in either the experimental or the expert group is associated with a higher intention to join or establish an energy community compared to the control group, with experts having even a higher intention compared to participants in the experimental group. A higher intention to join or establish an energy community in turn is associated with higher energy citizenship.

Finally, we found that the relationship between group and energy citizenship is no longer significant when the mediator is considered. This holds for all three comparisons among groups, X1: b = 0.090, t(432) = 1.010, p = .313, X2: b = -0.016, t(432) = -0.108, p = .914 and X3: b = -0.106, t(432) = -0,709, p = .478. The relative indirect effect supports the assumption that the relationship between group and energy citizenship is mediated by intention to join or establish an energy citizenship, as zero is not involved in the 95% confidence intervals, X1: b = 0.183, SE = 0.1073, 95% CI [0.037; 0.330], X2: b = 1.098, SE = 0.101, 95% CI [0.909; 1.305], and X3: b = 0.916, SE = 0.101, 95% CI [0.723; 1.127]. A Sobel test has been carried out to test the significance of the mediation. It revealed significant results for all three comparisons among the groups, Sobel X1 = 2.423, p = .016, Sobel X2 = 10.647, p < .001, Sobel X3 = 9.364, p < .001. The mediation model is depicted in Figure 2.

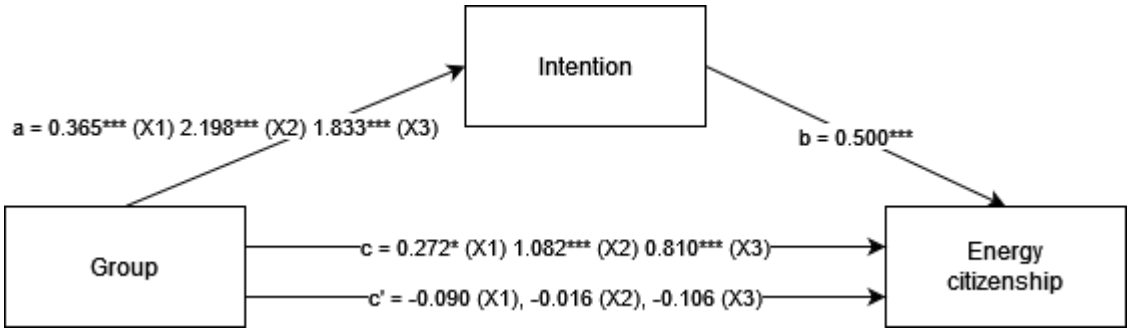

Figure 2. *Standardized regression coefficients for the relationship between experimental group and energy citizenship as mediated by the intention to join or establish an energy community. Note. X1: experimental vs. control group; X2: expert vs. control group; X3: expert vs. experimental group; * p < .05; ** p < .01; ***p < .001.*

1.2.3 Conclusion

With this study we wanted to investigate the impact of engaging with the website on energy communities on participants' perceived knowledge about energy communities and their

intention to establish or join such communities. The study employed an experimental design, randomly assigning participants to either an experimental group that engaged with the website or a control group that received only a short summary. Later, also an expert group with pre-existing knowledge on the topic was added. The results revealed significant differences among the groups in both knowledge and intention, supporting the main hypotheses.

The experimental manipulation had a significant effect on participants' perceived knowledge about energy communities (H1a). As expected, the experimental group, which engaged with the website, demonstrated significantly higher levels of knowledge compared to the control group. Moreover, participants in the expert group, although not exposed to the website, displayed the highest knowledge levels.

Consistent with expectations, the intention to establish or join an energy community also varied significantly across the experimental conditions (H1b). Participants in the experimental group expressed higher intentions compared to the control group, supporting the idea that engaging with the website positively influenced participants' attitudes and intentions. Notably, the expert group again exhibited the highest intention scores.

In further analyses we investigated the relationships between individual factors (energy citizenship, agency, and identification) and the effects of website engagement on knowledge and intention to join an energy community. We found that individual energy citizenship and agency and identification, along with being in the experimental or expert group, positively predicted both knowledge about energy communities as well as the intention to join or establish an energy community. The intention to join or establish an energy community was also predicted by sociodemographic variables indicating that being a younger male with a higher income is associated with a higher intention.

However, we were also interested in whether the relationship between engaging with a website and energy citizenship discussed above was mediated by a gain in knowledge about energy communities and/or intention to establish or join an energy community. The results demonstrate that engaging with a website is associated with higher energy citizenship trough a gain in both knowledge and intention. This relationship is even stronger for participants in the expert group, who indicated to have extensively engaged with information like the one presented in the website in the past.

The study's results imply that the website has the potential to be a valuable resource for individuals engaging with energy communities, influencing both their knowledge and behavioral intentions in a positive direction. However, several noteworthy limitations need to be considered. Firstly, the challenge of motivating participants in the experimental group to click on the website posed as a notable hurdle. A substantial number of participants had to

be excluded due to non-compliance, prompting reflection on the inherent interest or disinterest of individuals in such a web resource. This suggests that the topic of energy communities may be niche, appealing primarily to a specific subgroup of individuals. Consequently, future research should focus on identifying the characteristics and attitudes that attract individuals to this subject matter. Secondly, the study exclusively relied on subjective measures of knowledge, with participants responding to questions about their perceived knowledge of energy communities. The absence of objective knowledge assessments prevents us from concluding that individuals who engaged with the website acquired factual knowledge on energy communities. Participants may have experienced an increased sense of being better informed without necessarily gaining accurate knowledge.

In conclusion, this study demonstrated that engaging with a website on energy communities positively influenced participants' perceived knowledge and intentions to join an energy community. Additionally, pre-existing expertise played a significant role in shaping knowledge and behavioral intentions. The results suggest that a website like the Austrian coordination office for energy communities' website (energiegemeinschaften.gv.at) might indeed be useful for people in gaining knowledge and receiving information on energy communities and consequently also increasing their interest and intention to join an energy community as well as fostering their energy citizenship. Establishing such websites across Europe is a great challenge, but our tool – a handbook guiding the creation of such a website – is a first step in this direction.

1.3 Tool Two, energy community forum mockup

In the next phase, we proceeded to evaluate the second tool—namely, the prototype of the energy community forum. As emphasized during the co-creation workshops, a strong desire exists among individuals to foster connections, network, seek guidance from those with prior energy community experience and other experts, and find like-minded individuals (D5.2). This critical aspect is currently absent from the Austrian Coordination Office for Energy Communities' website (energiegemeinschaften.gv.at). To bridge this gap, we developed a complementary tool: an energy community forum mockup. This platform is designed to enable users to pose queries, offer insights to fellow users, and establish connections. It addresses the communal desire for an interactive space to engage, share knowledge, and encourage collaboration both within and across various energy communities. To demonstrate how such a forum would be integrated with a website, we realized a design (colors, fonds, etc.) similar to the EC² project's own web appearance.

To test the effectiveness of this second tool, we mainly wanted to know whether people would find a forum like that useful and if they can navigate the forum easily and find the information they are looking for. We therefore set up an online study to get a first insight into the user-friendliness of our forum design. In the online study, participants would get the chance to interact with the forum mockup and in the end, answer questions about it.

1.3.1 Method

1.3.1.1 Sample

The data were collected using the online survey tool Lime Survey and distributed to our teams' personal contacts. In total, 50 people clicked on the survey. After excluding people who did not answer any questions about the forum, we were left with a sample of 32 people. The final sample consisted of 17 females, 15 males. Among these participants, 50% were between 18 and 29 years old, 21.9% between 30 and 39, 15.6% between 40 and 49, and 12.5% were above 50 years old. Regarding education level, 78.1% had a university entrance diploma, while 21.9% did not.

1.3.1.2 Procedure

When clicking on the survey link, participants first received a short introduction to the study and were then asked to provide their consent. Next, they answered some questions regarding demographic variables, as well as their familiarity with the topic of energy communities, their interest in the topic, and their experience and amount of usage of the internet, social media, and online forums. They then received instructions to navigate through the forum mockup and answer a few questions about it. Afterwards, they answered the System Usability Scale (Brooke, 1996), focusing on the user-friendliness of the forum. Finally, they had the opportunity to indicate how much they liked the forum and, in two open-ended questions, express what they liked the most and what could be improved.

1.3.1.3 Measures

In the survey, we employed the following measures: people's familiarity with the topic of energy communities, their interest in the topic, and their experience and amount of usage of the internet, social media, and online forums were assessed using 6 self-constructed items on a 5-point Likert scale. Example items included, 'How would you rate your skills in using online platforms?'.

Questions regarding forum navigation were presented in an open format, requiring participants to seek answers within the forum and then write their responses in a textbox. Three questions in this format were used, with an example item being, 'How many posts are in the category "EEG foundation"?'.

To gauge the user-friendliness of the forum, we employed the System Usability Scale (SUS) developed by Brooke (1996). The scale comprises 10 items rated on a 5-point scale, ranging from 1 (do not agree) to 5 (agree). Example items included, 'I think that the various functions of the forum are well integrated.'. Cronbach's alpha of the scale in the current sample was good (α =.88).

1.3.2 Results

People in the sample indicated that they were, on average, moderately familiar with the topic of energy communities (*M* = 3.31, *SD* = 1.84) but very interested in the topic (*M* = 4.47, *SD* = 1.44; both measured on a 5-point scale). The average expertise in using the internet and online platforms was moderate in the sample (*M* = 3.46, *SD* = .70).

In total, 21 out of 32 people answered all of the exercise questions on using the forum correctly, suggesting that, for the majority, the forum seemed to be easy to use. However, about one-third of the people answered at least one question incorrectly, indicating a considerable number of individuals who faced some difficulties with using the forum.

We then recoded the reverse-coded items and calculated a mean score for the entire SUS scale. This also indicated that people seem to rate the usability of the forum quite high, with a mean of 4.22 (*SD* = .60; measured on a 5-point scale; see Figure 3)

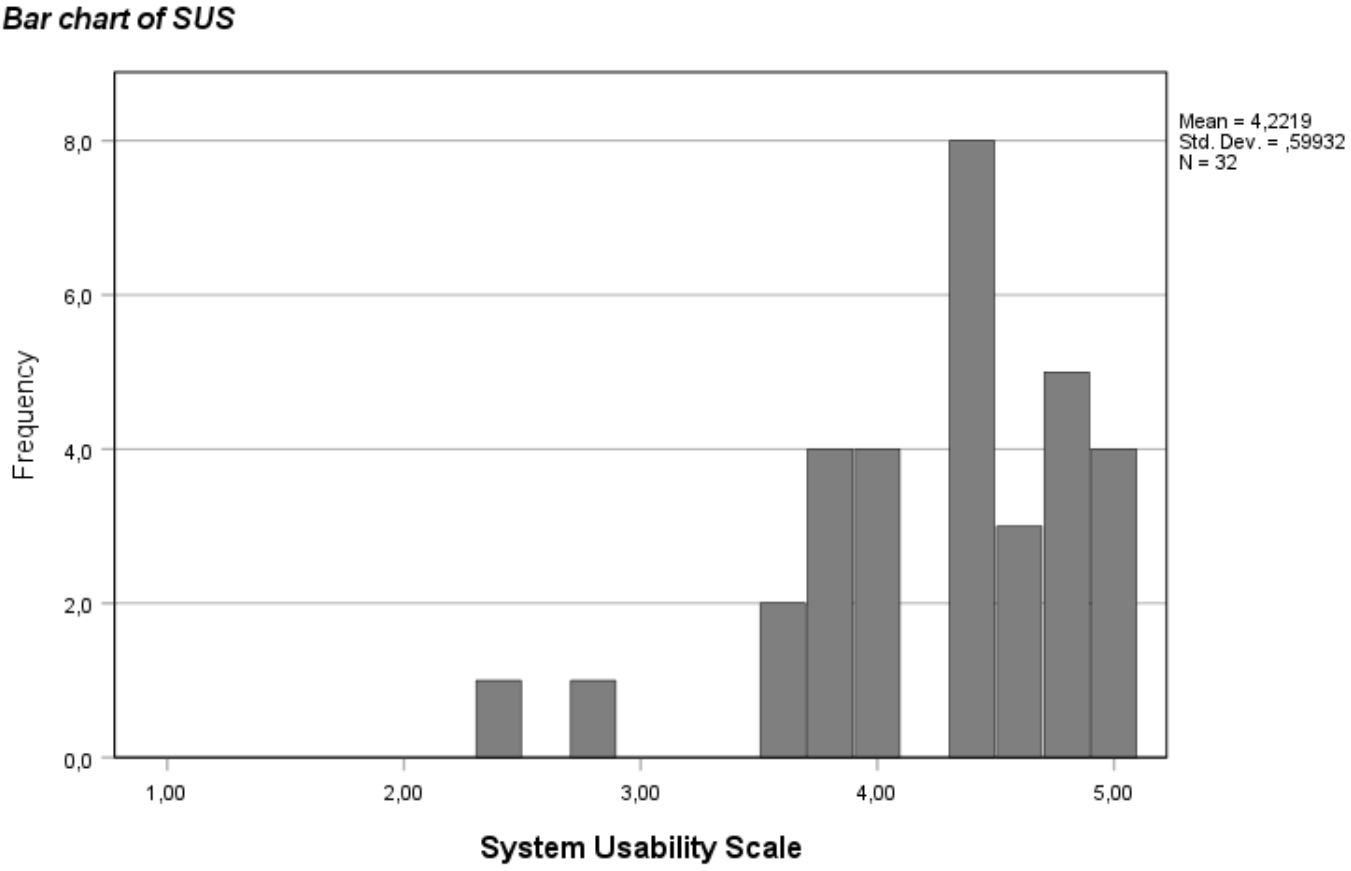

Figure 3. *Bar chart of System Usability Scale, scale range 1-5*

Furthermore, we analyzed whether the System Usability Scale correlated with any of the demographic variables, interest, and familiarity with energy communities, as well as people's expertise in using the internet and online platforms. We found no correlations between system usability, gender (*p* = .614), age (*p* = .130), or education (*p* = .409). Moreover, system

usability was not correlated to expertise in internet and online platforms (p = .193) and interest in energy communities (p = .260) or familiarity with energy communities (p = .977). Lastly, we checked the two open-ended questions asking people what they liked about the forum and what could still be improved. People most often reported that they liked the clear and simple structure of the forum and the organization into different categories (see Figure 4). When asked about possible improvements, people wanted a thumbs-up icon instead of an arrow for upvoting or liking a post, less white space, more colours, a news blog, and a home button (as a link to the landing page). However, a lot of people also mentioned that after a short use, they did not find anything that could be improved (see Figure 5).

Figure 4. *Word cloud of what people liked about the forum. The bigger a word, the more often it was reported.*

***Figure 5**. Word cloud of what people would like to see improved in the forum. The bigger a word, the more often it was reported.*

1.3.3 Conclusions

In this study, we aimed to evaluate the prototype of an energy community forum as a tool to facilitate connections, provide guidance, and foster collaboration within and across various energy communities and interested people. The co-creation workshops emphasized the need for such a platform, addressing the importance of networking.

The online study provided valuable insights into the potential usefulness of the energy community forum. The participants, who were on average moderately familiar with energy communities but highly interested in the topic, navigated through the forum mockup, answering questions and providing feedback.

The results indicated that a majority of participants found the forum easy to use. The System Usability Scale (SUS) was employed to assess the user-friendliness of the forum, indicating overall good usability. Further analysis revealed no correlations between system usability and demographic variables, expertise in internet platforms or interest and familiarity in energy communities. Thus, the forum should be usable across the population.

Participants appreciated the clear and simple structure of the forum, along with its categorization. Improvement suggestions included reducing white space, adding more

colors, implementing a news blog, and including a home button. It's noteworthy that a substantial portion of participants expressed satisfaction, stating that they did not identify significant areas for improvement after a short period of use. One also should keep in mind, that in this test the forum was not embedded in a website – as it would be intended. Some of the suggestions, like changing the color scheme or adding a news blog, might change if that would be the case.

In conclusion, the findings suggest that an energy community forum holds promise as a valuable tool, as reflected in participants' positive feedback and high usability ratings. The study provides a foundation for further refinement based on user suggestions, aiming to create an effective platform that enhances collaboration and engagement within the energy community domain.

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3 Appendix

3.1.1 SUS score calculation

In the original article of the SUS scale by Brooke (1996), they describe a way to calculate the final SUS score. To derive the SUS score, first the sum of each item is calculated. Each item's score contribution ranges from 0 to 4. For items 1, 3, 5, 7, and 9, the score contribution is the scale position minus 1. For items 2, 4, 6, 8, and 10 (the reversed items), the contribution is 5 minus the scale position. By multiplying the sum of the scores by 2.5, we arrived at the overall value of SUS. The SUS scores have a range of 0 to 100. In our survey, the overall score of the SUS was 80.63, indicating overall good usability of the forum.

3.1.2 SUS Scale items

1. I think that I would like to use this system frequently
2. I found the system unnecessarily complex
3. I thought the system was easy to use
4. I think that I would need the support of a technical person to be able to use this system
5. I found the various functions in this system were well integrated
6. I thought there was too much inconsistency in this system
7. I would imagine that most people would learn to use this system very quickly
8. I found the system very cumbersome to use
9. I felt very confident using the system
10. I needed to learn a lot of things before I could get going with this system