Bottom-up Initiatives for Photovoltaic: Incentives and Barriers

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ABSTRACT

When facing the challenge of restructuring the energy system, bottom-up initiatives can aid the diffusion of decentralized and clean energy technologies. We focused here on a bottom-up initiative of citizen-funded and citizen-operated photovoltaic power plants. The project follows a case study-based approach and examines two different community initiatives. The aim is to investigate the potential incentives and barriers relating to participation or non-participation in predefined community PV projects. Qualitative, as well as quantitative empirical research was used to examine the key factors in the further development of bottom-up initiatives as contributors to a general energy transition.

KEYWORDS

Photovoltaic adoption, PV diffusion, Community power plants, Community renewables, Renewable energy cooperatives, Citizen engagement

INTRODUCTION

Climate change and energy security are strong drivers in a transition to sustainable energy. Increasing energy prices and the high dependence on non-renewable resources may be attributed to the current strong focus on centralized energy systems which operate mostly on the basis of fossil fuels [1]. By producing electricity and heat closer to the point of use decentralized energy systems can help counter such adverse effects [2]. Decentralized energy is to be preferred over traditional centralized electricity generation in that it serves to reduce distribution inefficiencies and facilitates the development of an increased contribution from renewables [3].

Bottom-up initiatives can play a crucial role in achieving more decentralized structures. Community energy projects are attracting increasing attention as potential sources of innovation in the transition towards sustainable energy [4]. Recent research, for example, has examined the role of community-based initiatives in the transition to a low-carbon, sustainable economy in the UK [5], as well as the role of new technologies in the decentralized production of renewable electricity, heat, combined heat and power (CHP) and fuels [6]. One important technology for decentralized production is photovoltaic [7].

We thus focused our research on citizen-based solar power plants as bottom-up initiatives in photovoltaic (hereafter, PV) technology. Due to its high technological potential and the rapidly decreasing costs, PV is an increasingly promising element of renewable energy production, and is the fastest growing renewable energy source worldwide. The Austrian scale-up target for PV, as stated in the electricity law of 2012

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[8], is 1,200 MWp of installed capacity by 2020 (installed capacity in 2011: 173.8 MWp) [9].

At present, various forms of PV bottom-up initiatives are taking root in Austria, extending across all provinces. These include classical initiatives at the level of local communities and associations, as well as initiatives involving local and regional energy suppliers who wish to provide a possibility for their customers to invest and participate in renewable energy production. A tendency towards the professionalization of bottom-up initiatives may thus be observed, especially in the field of wind energy. Bottom-up initiatives in the field of photovoltaic have only begun to emerge in the past two years. Recent research on energy cooperatives in Austria reveals that the development paths for such initiatives comprise a) replication of other initiatives as a result of word of mouth information exchange, b) the emergence of mid-size enterprises from what were initially relatively small projects, and c) the entry of new actors onto the scene such as profit-orientated energy suppliers offering citizen investment models [10]. Generally, community participation initiatives offer several advantages for consumers, e.g. they can reduce the associated costs and risks for the individual, or minimize time and effort. To make the most of their potential, however, one needs to remember that bottom-up initiatives must also be integrated within the overall (renewable) energy strategy of Austria.

Buying a photovoltaic system demands high individual involvement since it is probably a decision that people make only once in their lives [11]. As a consequence, analysing and assessing how residents interpret community needs can often lead to constructive ideas and decisions [12]. Most studies focus on quantifying economic effects [13] and neglect the underlying conditions and constellations which support and enable decentralized electricity generation as part of local economic development [14]. Bomberg and Even [15] focused their research on the mobilization of citizens in the specific area of community energy and point out that community action must offer specific incentives in order for citizens to be willing to participate. In addition to any individual benefits arising, community renewables also support the lowering of emissions and help secure a more sustainable energy supply. Such benefits accrue to everyone, not only to direct participants, and these also need to be highlighted in such policy initiatives.

In this on-going research we analyse the role of bottom-up initiatives in the area of photovoltaics, and assess the potential for active citizen engagement in the development of local cooperatives and in promoting the usage of decentralized renewable energy. The main interest lies in the identification of key factors (incentives and barriers) for the further development of community-based photovoltaic projects.

The focus is thus placed on the examination of public perceptions and motives with respect to participation in community-based energy projects. Our main research questions are:

- What attitudes do people have towards community-led PV projects?
- What are the important social, psychological and economic determinants or motives driving participation or non-participation in different types of community-based initiatives in the field of photovoltaics?
- How could the further diffusion of community power plants in rural regions be supported?

The paper is structured as follows: The next section briefly describes the two communities that have been selected for our case study. On the one hand we focus our research on a “community of locality”; the municipality of Ligist/Austria, and its attempts to implement a public photovoltaic power plant. On the other hand we take a

closer look at a "community of interest", which in our case is represented by a photovoltaic cooperative of farmers in Hartberg/Austria. The section "methodology" gives an overview of the qualitative and quantitative empirical research, followed by a section presenting our findings and a related discussion. The final section offers conclusions and implications for the future development of bottom-up initiatives.

Case study selection

The definition of a community renewable energy project is quite flexible, and different groups apply the term to various types of scheme [16]. While there are different models of community ownership and use [17], the focus of our research is on investigating bottom-up initiatives which build upon already existing structures.

A distinction is thus made between "communities of interest" and "communities of locality" [18]. A group of individuals, who share a common interest, though without necessarily living in the same local area, is referred to as a "community of interest". In contrast, "communities of locality" are defined in terms of a specific geographical boundary within which people live together. Based on this distinction, we examined two successful models concerning community-led PV production and use.

Community of interest. Being well aware of the energy intensity of farming and of the uncertainties/volatilities existing on the energy market, an association of farmers founded a cooperative for PV adoption in agriculture. This farmers' PV cooperative is situated in the district of Hartberg, in Eastern Styria (Austria) and provides multi-level assistance in the construction of PV plants on farm buildings. The cooperative supports farmers with various legal and practical issues such as processing applications for subsidized feed-in tariffs, setting up contracts with grid-providers, expert assessment of plant location, applying for building permits, ordering panels and their installation, etc.

Currently over 150 farmers have joined the PV society, which is quite a considerable number for rural Austria. Organizing a community around a specific issue is often difficult [19], but this cooperative serves as an excellent example of a successful community of interest and is a case well worthy of study.

Community of locality. A municipality in the Austrian countryside plans to launch a community power plant based on PV and to offer energy advice to its citizens. The municipality of Ligist is located in the district of Voitsberg, in Western Styria (Austria) and intends to build a community PV power plant on the roof the elementary school. As a consequence, citizens are being offered the opportunity to participate in this project via share certificates.

METHODOLOGY

In order to answer our research questions, we applied a two-stage study design. In an initial exploratory step we conducted semi-structured interviews with initiators and (potential) participants of our two bottom-up case studies. Based on the insights gained in these interviews we conducted a quantitative empirical investigation among all community members of the two case studies.

Qualitative interviews

The semi-structured interviews focused on the attitudes of people concerning community-led PV projects and were conducted between January and February 2012 with farmers participating in the PV cooperative (n = 18), and between March and April 2013, with the citizens of Ligist (n = 10). The qualitative data, recorded through the

interviews, was evaluated using the software MAXQDA 11. The evaluation of the outcome of the interviews was made based on the approach described in Mayring [20].

Quantitative survey

The questionnaire aimed at gathering data concerning (1) general environmental problem awareness (2) (potential) motives and barriers for the participation and non-participation in the community-led PV project and (3) demographics. In order to measure (1) and (2), we designed appropriate items and applied a 5-point Likert scale for the dataset of Ligist. The dataset of the farmers' cooperative was used in previous research and was collected on a 6-point Likert scale. To overcome the discrepancies arising as a result of the diverging scales in our two samples, we normalized the data between 0 and 1 and used these values for our further analysis.

- PV cooperative Hartberg: Questionnaires were sent to all 148 farmers who at the time of the survey were members of the PV society. A total of n = 67 respondents returned the questionnaires, resulting in a response rate of 45.3%. The respondents had joined the initiative in 2011, and their plants entered into service between November 2011 and September 2012. The postal survey was conducted between September and November 2012. Respondents were asked to complete the questionnaire and return it by using a pre-paid envelope; (1)
- Households situated in the municipality of Ligist (N = 1,000). The questionnaire was sent via a special edition of the local community newspaper called "Ligister Nachrichten" to all households within the municipality of Ligist. Simultaneously, citizens also had the opportunity to fill in the questionnaire online, using the web survey tool Limesurvey. All in all, a total of n = 135 respondents returned the questionnaire, resulting in a response rate of 13.5%. The survey was conducted between March 2013 and June 2013. The paper-based questionnaire was collected via boxes situated at some main spots within the municipality (bank office, grocery store etc.). (2)

A standard statistical software package, SPSS 21, was used to analyse the questionnaire with respect to our research questions. First, we used descriptive statistics to evaluate response frequencies (median values were calculated from grouped data). In a second step we applied a non-parametric test – the Wilcoxon test for dependent variables - to compare the medians of the observed variables.

RESULTS AND DISCUSSION

Results show that while eco-attitudes are important motivating factors when deciding whether to join a citizen power plant, it is the economic drivers, such as secure investment, governmental subsidies or financial return which play a crucial role in engagement. Social network effects are also highly important in the diffusion process of such initiatives. In particular, collaborative initiatives are able to mobilize resources and to create opportunities for actions that are not available to a single actor.

Looking at communication channels, it was found that public meetings geared towards the provision of information on community power plants tend to have a high impact on people's decision making, as does word of mouth, where people, who are already part of the initiative, inform others of their experience.

Attitudes towards community renewables

The qualitative results from the interviews highlight the relevance of implementing energy projects at a local level. Interviewees mentioned that they

appreciate being involved in community actions concerning the future development of their environment: Hence, public participation and personal involvement play an important role in supporting bottom-up initiatives in the field of photovoltaics.

Another key motive for Ligist in supporting the future realization of a community PV power plant is the growing interest in sustainability issues. Implementing sustainability at a local level leads to ecological as well as economic improvements. The generation of electricity within the community can be seen as a first step towards energy autarky, as well as towards independence from energy companies and imported resources. The local and clean production of energy also has additional benefits in the form of fewer emissions and lower environmental impact. Apart from communal aspects, such as the feeling of contributing to a better environment, perceived personal benefits are crucial when deciding whether to participate or not in such a community initiative. Both the farmers involved in the PV cooperative, as well as the citizens of Ligist, stated that financial drivers such as lower electricity costs or security of investment are major elements in the decision making process.

Additional results revealed that network effects and information channels can positively change people's perception towards community PV projects. Farmers from the PV society referred to the high relevance of informational events during the decision making process. Also, word of mouth played a huge role in the farmers' adoption process. Farmers also mentioned that they asked members already participating in the project about their experience before deciding to join. To a certain degree, this can also be observed in the community of Ligist. If neighbours, friends or relatives have positive attitudes towards the community PV power plant and are willing to participate, then citizens who are undecided can also be encouraged to join the project.

Key-factors for the engagement in a community PV power plant

Incentives. Respondents of the questionnaire were asked to state the relative importance of specific motives when deciding to join a community PV project. Responses to the questions were graded from 0, very important, to 1, unimportant. The results of the case study are presented in Table 1 (for citizens of Ligist) and Table 2 (for farmers of the PV society).

The differences between the items listed (incentives and barriers) in the two case studies is due to the fact that the farmers' PV society is based on the installation of individual PV systems on the roofs of their agricultural buildings (contracting), while the community PV power plant of Ligist relates to a citizen-funded and citizen-operated photovoltaic power plant proposed for a public roof in the municipality. As a consequence, different facts have to be considered in the decision making process. To aid understanding of the key factors, in our analysis we focused on financial, ecological, social, and technical attitudes.

The most important incentives reported by the inhabitants of Ligist related to ecological issues such as "the usage of PV raises the degree of independency of fossil fuels and nuclear power" and "PV is seen as a clean technology". Economic arguments were also thought important when implementing a community PV system, i.e. "the added value remains in the region", or "return of investment within service life".

Other financial aspects, mainly based on the individual's economic point of view, e.g. "self-determination of financial share or funding", were given lower priority.

Somewhat contrary to expectations, social drivers such as "improving the image of the municipality" or "strengthening of social solidarity within the community" do not seem to be crucial for the participation process. The Wilcoxon test confirms that these

social motives are significantly less important than technical aspects, such as "no personal efforts for installation and maintenance" (z ($n = 122$) = -2.732, $p = 0.006<0.01$).

Table 1. Incentives/Municipality of Ligist - Descriptive Statistics

(Potential) incentives [a]	**Citizens of Ligist**				
	N	Median [b]	SD [c]	min.	max.
Independency of fossil fuels and nuclear power	125	0.09	0.22	0.0	1.0
Clean technology	125	0.09	0.21	0.0	1.0
Added value remains in the region	125	0.10	0.21	0.0	1.0
Return of investment within service life	121	0.10	0.21	0.0	1.0
Independency from electricity tariffs /power companies	123	0.13	0.24	0.0	1.0
Self-determination of financial share	122	0.13	0.25	0.0	1.0
Funding via public sector	123	0.17	0.29	0.0	1.0
No personal effort needed for installation and maintenance	122	0.18	0.28	0.0	1.0
Improving the image of the municipality	124	0.26	0.33	0.0	1.0
Strengthening of social solidarity within the community	125	0.29	0.39	0.0	1.0

a) 0 very important - 1 unimportant

b) Calculated from grouped data

c) Standard Deviation

Table 2. Incentives/Farmers' Cooperative - Descriptive Statistics

Incentives [a]	**Cooperative of farmers**				
	N	Median [b]	SD [c]	min.	max.
Responsibility for future generations	66	0.03	0.18	0.2	1.0
Alternative to nuclear power	67	0.06	0.17	0.0	1.0
Payback period < 13 years	67	0.06	0.17	0.0	1.0
Clean technology	67	0.07	0.19	0.0	1.0
Own production of electricity	67	0.09	0.18	0.0	1.0
Lower electricity costs after 13 years	67	0.09	0.19	0.0	1.0
Promote a future technology	66	0.13	0.19	0.2	0.8
Independency from electricity tariffs /power companies	67	0.13	0.23	0.0	0.8
Secure investment	67	0.22	0.23	0.0	1.0
Fascinating technology	66	0.28	0.28	0.2	1.0
Being a role model	66	0.39	0.33	0.2	1.0

a) 0 very important - 1 unimportant

b) Calculated from grouped data

c) Standard Deviation

The responses from farmers who joined the PV society showed that similar motives for adoption were at play. Ecological issues (i.e. "responsibility for future generations" and "alternative to nuclear power") were referred to as being very important: a possible

explanation for this probably lies in the fact that anti-nuclear energy attitudes are common in Austria.

Once again, financial aspects are among the strongest motives in the decision making process. It can also be observed that social aspects (i.e. "being a role model") are significantly less relevant than technical ones (i.e. "fascinating technology") ($z (n = 66) = -2.947$, $p = 0.003<0.01$).

Although motives related to environmental and ethical consideration seem to have a high impact on the decision making process, they, in contrast to economic motives, fail to predict PV adoption. Possible reasons are that many people are opting for an attractive investment model. The potentially higher rate of return than that offered by banks, together with the perceived lower level of risk, appear to be quite convincing factors in the decision to adopt PV.

Barriers. Turning now to the potential barriers to participation in a community PV power plant, the analysis reveals that respondents saw the listed concerns as being relatively less important than the aforementioned incentives. However, focusing on the main barriers indicated by both groups (the citizens of Ligist, and the farmers) shows again the high influence of financial aspects. As indicated in Table 3, the inhabitants of Ligist refer to "currently too little private funding" and "long pay-off period" as being major concerns. However, directly connected to the underlying objective of community renewables, is the "dependency on decision making of community/others" or the argument "uncertainty regarding the realization of the project" which seems to have a certain affect in the decision making for a collective PV system.

Table 3. Barriers/Municipality of Ligist - Descriptive Statistics

Barriers [a)]	**Citizens of ligist**				
	N	Median [b)]	Sd [c)]	Min.	Max.
Currently too little private funding	109	0.29	0.34	0.0	1.0
Long pay-off period	108	0.32	0.31	0.0	1.0
Dependency on decision making of community/others	106	0.33	0.29	0.0	1.0
Uncertainty regarding liability and legal affairs	108	0.36	0.30	0.0	1.0
Uncertainty regarding the realization of the project	108	0.37	0.27	0.0	1.0
Lack of information	108	0.40	0.34	0.0	1.0
Bureaucratic burdens	108	0.47	0.28	0.0	1.0
Susceptibility to extreme weather conditions	109	0.50	0.31	0.0	1.0
Potential malfunctioning	109	0.52	0.31	0.0	1.0
Destruction of the landscape	109	0.64	0.34	0.0	1.0
Lack of time	105	0.65	0.28	0.0	1.0

A) 0 very important - 1 unimportant

B) calculated from grouped data

C) standard deviation

Due to the fact that photovoltaics are perceived as being a relatively mature technology there were hardly any worries about technical issues, e.g. "potential malfunctioning". The high acceptance of photovoltaic systems in our society means that

potential concerns such as "destruction of landscape", are not considered as being important when thinking about participating in a community PV power plant.

The responses from farmers reveal similar results, with economic factors being listed as major concerns. Table 4 indicates that "investment volume" and "funding" are rated significantly higher than worries concerning collaboration with energy companies ("problems with energy companies") (z (n = 67) = -2.287, p = 0.022<0.05). Since bottom-up initiatives in the field of photovoltaics are relatively new, experience on how electric power companies intend to deal with this emerging field is severely lacking.

Similar to the results of the case study on the community of Ligist, farmers express no major concerns regarding photovoltaic technology. Hence, arguments such as "no trust in technology" or "potential malfunctioning" are not considered as reasons for refusal.

Table 4. Barriers/Farmers' Cooperative - Descriptive Statistics

Barriers [a]	**Cooperative of farmers**				
	N	Median [b]	SD [c]	Min.	Max.
Investment volume	67	0.37	0.33	0.0	1.0
Uncertainty regarding the amount and time of funding	67	0.42	0.32	0.0	1.0
Problems with electric power companies	67	0.56	0.30	0.2	1.0
Drop in performance	67	0.56	0.29	0.0	1.0
Financial uncertainty	66	0.57	0.31	0.2	1.0
Expected problems with approval procedure	66	0.58	0.34	0.0	1.0
Susceptibility to extreme weather conditions	67	0.66	0.31	0.0	1.0
Potential malfunctioning	66	0.72	0.28	0.2	1.0
No trust in technology	66	0.80	0.27	0.2	1.0
Maintenance issues	67	0.82	0.27	0.0	1.0

a) 0 very important - 1 unimportant

b) Calculated from grouped data

c) Standard Deviation

CONCLUSION

As we have seen, different types of bottom-up initiatives are currently taking root in Austria. Within a case study-based approach, we focused on two successful community-led PV projects – a community of interest, and a community of locality. A key question is the extent to which their success, however measured, can be replicated in other locations and contexts in the absence of the initial dynamics of innovation or the involvement of key enthusiasts and social entrepreneurs [17].

There are plenty of highly motivated people willing to promote renewable energy projects within small networks and communities. Thus, the initiation and development of such projects needs to be fostered by promoting funding policies and framework conditions such that the added-value that bottom-up initiatives can contribute to a future energy transition may be exploited to the full.

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