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Acceptance of AgriVoltaics – A Multi-Stakeholder Survey for a German AgriVoltaic System in Fruit Farming

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Abstract. Public perception of Agri-PV cannot be reliably assessed at this time, in part because the agricultural context and appearance of each Agri-PV system varies widely. Therefore, within the research project "Agri-PV Fruit Growing", a social impact analysis of Agri-PV in a fruit growing region (predominantly apple growing) was carried out in May 2021 and interviews with local social representatives with public functions (multi-stakeholder approach) were conducted. The goal of the survey, which took place in parallel to the implementation of a pilot Agri-PV plant, was to get detailed insights to acceptance factors among the relevant stakeholder groups. As well, the implications regarding communication and informal participation in future Agri-PV plants will be elaborated.

Keywords: Acceptance, Stakeholder Perspectives

1. Introduction

Generally, the expansion of renewable energies receives broad social approval in central Europe [1], but often encounters resistance at the local level [2]. Regarding the increasingly urgent expansion - especially of integrated PV systems such as AgriVoltaics (Agri-PV) - challenges such as private-sector willingness to invest and tolerance of landscape changes must be borne by society as a whole [3]. The reasons for the discrepancy between a general social acceptance of the energy transition and a very specific, negative attitude towards the local expansion of renewable energies are manifold. Above all, subjective risk and benefit considerations play an important role: they lead to fears about possible financial, health and aesthetic disadvantages associated with local changes in the environment, especially land use and landscape [2].

2. Research goal

Public perception of Agri-PV cannot be reliably assessed at this time, in part because the agricultural context and appearance of each Agri-PV system varies widely. Therefore, within the research project "Agri-PV Fruit Growing", a social impact analysis of Agri-PV in a fruit growing region (predominantly apple growing) was carried out in May 2021 and interviews with local social representatives with public functions (multi-stakeholder approach) were conducted. The goal of the survey, which took place in parallel to the implementation of a pilot Agri-PV plant, was to get detailed insights to acceptance factors

among the relevant stakeholder groups. As well, the implications regarding communication and informal participation in future Agri-PV plants will be elaborated.

3. Methodology

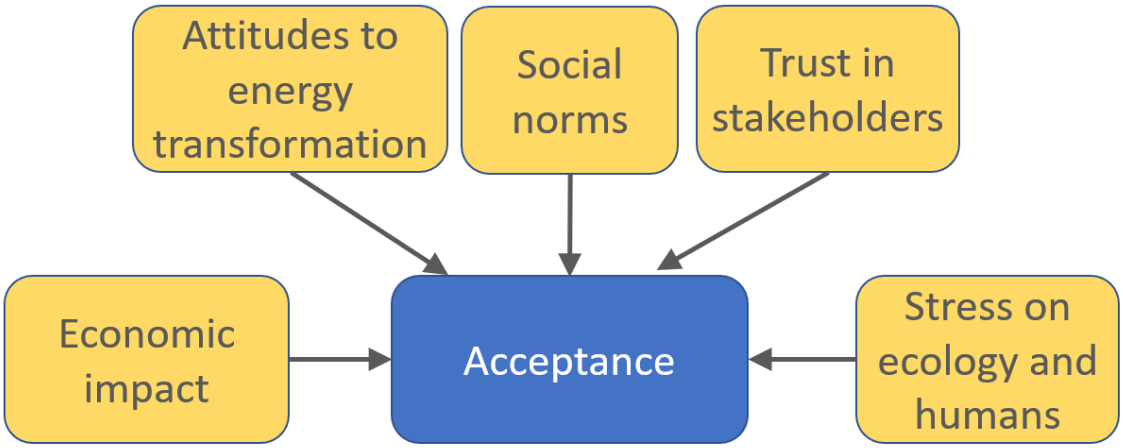

Figure 1: Influencing factors for social acceptance [2]

The social acceptability study was conducted through a qualitative survey design in the form of a semi-standardized guided interview. The analysis of acceptance factors in the context of Agri-PV serves to investigate subjective views and behaviors of different stakeholders on site of the research project "Agri-PV Obstbau", in the Rhineland-Palatinate district of Ahrweiler. This includes 17 local representatives of the administration, the energy sector, environmental and species protection associations, the agricultural sector, farmers' associations, local politics, and science. The answers were anonymized, selectively transcribed and content analysed with MAXQDA.

In terms of content, the interview questions are based on the acceptance model for renewable energies according to Hübner et al ([2] (Figure 1). A transfer of the model to Agri-PV was realized and the interviews were targeted to find out, for which stakeholder specific influencings factors are applicable. The methodological approach was designed to address the following main points and then draw conclusions on the acceptance factors during the analysis of the interviews.

The coding system was based on the so-called Jobs-To-Be-Done theory (JTBD) according to Christensen and Ulwick [4]. This theory states that various forces are influential in the establishment and advocacy (individual and societal) of an innovation, such as Agri-PV. Thus, there are two forces - called push (translated here as improvements) and pull (translated here as gains) - that promote the advocacy of a new technology. Push forces include all factors that represent a current, critical or negative actual state and based on this, push for an improvement of the current situation, i.e., toward innovation. Pull forces, on the other hand, include factors that show such positive effects through the implementation and use of the technology that the technology is attractive and wanted in this way.

Opposing these are two inhibiting forces, referred to as Anxiety (translated here as Social Inhibitors) and Habit (translated here as Structural Inhibitors). These forces include factors that portray an innovation as critical, create uncertainty and anxiety, and thus inhibit advocacy.

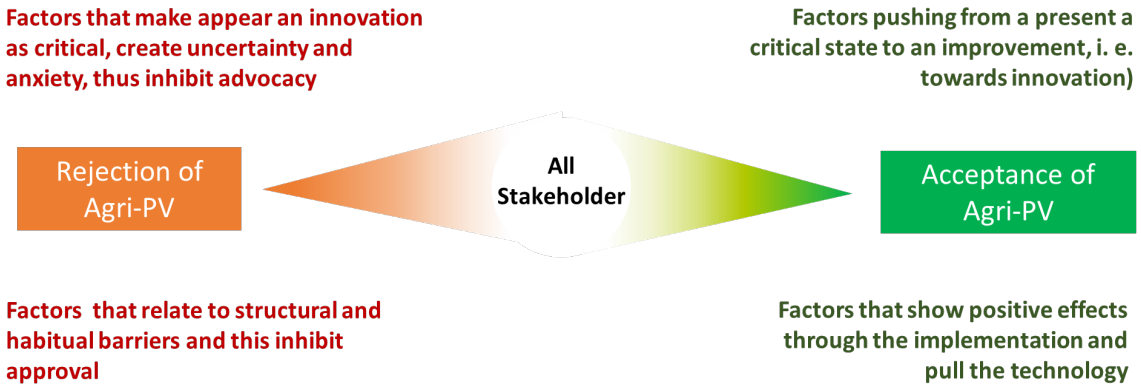

Figure 2. Display of the four forces of the JTBD Theory [4] in the case of Agri-PV (Source: Fraunhofer ISE, own design)

4. Results

4.1 Cross-Stakeholders results

Stakeholders across the board show a majority positive attitude towards the Agri-PV technology for the fruit growing region, its future, and the research project "Agri-PV Fruit Growing". In general, the research results are awaited with great interest.

The interview results illustrate that the acceptance of Agri-PV (as is the case for energy renewables in general) strongly depends on regional conditions [5]. In the region of the research project "Agri-PV Fruit Growing", films and hail protection nets have already been applied on a large scale in fruit growing for several years. The familiar sight of overbuilt cultivated landscape favors the aesthetic assessment of technical structures like the Agri-PV, especially if it shows further synergetic effects as dual land use for food and energy production, economic gains for farmers, and positive environmental impacts. For farmers, the crop protection factor of Agri-PV also plays a decisive role. Uncertainties regarding the economic viability of an Agri-PV system and its integration into modern agricultural work management, as well as the current legal framework for its construction, are barriers to acceptance. For species and environmental protectionists, possibly occurring negative environmental impacts are also to be considered critically.

4.2. Differentiated Stakeholders' results

If we look at the individual stakeholders and compare groups with the same number of participants, we see differences in the weighting of the factors. Table 1 shows the factors in the facilitating and inhibiting factors that were named most frequently per stakeholder. The evaluation shows that, particularly regarding the inhibiting factors, solutions should be developed with the specific stakeholders in order to achieve a sustainable improvement.

Stakeholder group	Factors that promote the advocacy of Agri-PV	Factors that inhibit the advocacy of Agri-PV
Local Administration	Contribute to climate targets and expansion of renewables	(Local) resistance, Changed landscape

Energy sector	Competition for land & rising lease prices	(Local) resistance, Local politics and administration, Changed landscape
Agricultural sector	Extreme weather events as a result of climate change, Competition for land & rising lease prices, Crop protection function of the Agri-PV system	
Agricultural associations	Extreme weather events as a result of climate change, Future development of the agricultural sector	Preference for other technologies over Agri-PV, Disinterest & established behavior patterns
Environmental and species protection associations	Unsustainable agricultural practices, Positive environmental impact	Changed landscape, Local politics and administration, Disinterest & established behavior patterns
All stakeholder groups	Economic profit, Multiple use of the area, Landscape with films and anti-hail nets,	Economic efficiency and financing, Current legislation

Table 1: Most relevant factors according to specific stakeholder groups (Source: Fraunhofer ISE, own data)

The familiar sight of overbuilt cultural landscape favors the aesthetic assessment of technical structures such as the Agri-PV, especially if it shows further synergy effects. These include, above all, dual land use for food and energy production, economic gains for farmers and positive environmental effects. For farmers, the crop protection factor of Agri-PV also plays a decisive role. Uncertainties regarding the economic viability of an Agri-PV system and its integration into modern agricultural work management, as well as the current legal framework for its construction, are barriers to acceptance. From the point of view of species and environmental protection, possible negative environmental impacts must also be viewed critically.

Overall, Agri-PV is perceived as positive in the context of apple and fruit growing. Nevertheless, among all stakeholder certain critical factors on the acceptance of Agri-PV have been raised. Thus, this study confirms the need for early proactive communication in Agri-PV projects, so that local actors and especially the population are enabled to give the project a positive meaning and to recognize the benefits. Based on the stakeholders' assessment, concrete communication concepts can be developed. To increase acceptance, the focus for further technology dissemination should be on the economic efficiency of the system and the legal facilitation of construction projects.

Data availability statement

The data supporting the results of this contribution is of qualitative nature and anonymous interview transcriptions can be accessed through the authors of this paper.

Author contributions

Sebastian Gölz was responsible for project administration, supervision, visualization, and writing – original draft as well as review & editing. He assisted in the funding acquisition, conceptualization, and methodology development.

Franziska Larisch was responsible for conceptualization, implementing the methodology, investigation, data curation, analysis and validation and assisted in visualization.

Competing interests

The authors declare no competing interests.

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