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**TITLE: Social and market acceptance of photovoltaic panels and heat
pumps in Europe: A literature review and a survey**

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1. Introduction

Quick adoption of renewable energy solutions (RETs) in buildings is a key factor to achieving the European climate and energy targets. The necessary technologies are available but non-technological barriers still exist [1]. Social acceptance of RETs has been conceptualized, suggesting that there are at least three dimensions; socio-political, community and market [2]. Efforts to assess the adoption of RETs should cover more than one form of acceptance.

Solar photovoltaics (PVs) are one of the most popular RETs available in the market, have been available for decades and have been heavily studied. Most of the barriers to their diffusion identified in previous studies are related to policy support, technical performance and finances [3]. Heat-pumps (HP) have also emerged as environmentally friendly solutions to supply buildings' energy demand. Nevertheless, few studies have focused on user-related aspects and public perceptions of HPs; with many aspects related to public perception that can affect the uptake of the technology in residential buildings [4].

The aim of this article is to conceptualize and assess the social and market acceptance of the innovative SunHorizon technologies (PVs and HPs) in Europe, in order to identify which aspects need more focus for the replicability of these key solutions for a low carbon building sector to a wider audience. The work presented in this article is part of the SunHorizon EU-project [5].

2. Methodology

A review of the existing scientific literature on social and market acceptance of similar technologies was carried out to contextualize acceptance and frame the survey questions to build on the frontline knowledge, and to understand what drives acceptance and adoption. A literature review of EU projects was carried out to gather knowledge from projects like SunHorizon, to obtain guidelines for the development of the survey.

Data about the social and market acceptance amongst different stakeholder groups was collected at the demo sites in SunHorizon and beyond, through an online survey. To reach a wide public for the social and market acceptance, the EU survey service from the European Commission was utilized. The partners responsible for each demo site were tasked with identifying local stakeholders, contacting them via e-mail and distributing digital links to the respondents. However, some sites required survey distribution in paper form.

The survey was applied mainly to stakeholders in the countries where SunHorizon demo sites are implemented; Germany, Spain, Belgium and Latvia. Still, stakeholders outside the project were also contacted via social media. The survey was applied to the following stakeholder groups:

- Business representatives
- Private building owners
- Public building owners
- General public, residents and end-users

For social acceptance, the data collected is used to understand how to make stakeholders more positive towards the technology and thus less likely to oppose it. As for market acceptance, the data is used to identify the barriers and motivators for different stakeholders to adopt the technology. The data obtained from the survey was analysed using multiple approaches including multivariate data analysis with Principal Component Analysis (PCA) and a MANOVA (Multivariate ANOVA), followed by a COST (consider one separate variable at a time) analysis, using the ANOVA test.

3. Results

The results from the literature review show that three aspects are the most common barriers preventing further adoption of renewables; low availability of information about the technology, financial aspects and sociodemographic factors (e.g. income level and educational level). Low availability of information about how the technology works, the proper way to

operate it, the investment and operational costs, the government incentives available and the installation process can hinder the adoption of renewables. Financial aspects can be positive or negative for adoption; as economic incentives such as tax deductions or easy access to loans have been found to foster, whereas the investment costs and payback period appear as barriers.

The results from the social acceptance part of the survey identify only one aspect where groups with very high environmental index were more positive towards the technology than other groups; namely that the technology has a positive effect on the landscape. The market acceptance results yield stronger support for environmental values being positively influential for adopting clean technologies and makes a distinction for the following aspects; the system will increase the value of the property, the cost savings potential is certain, new and innovative technology is an opportunity and the system performance is certain.

The respondents are to a large extent interested in the technology and curiosity has been found to be an important driver, as in previous literature. Availability of information was also identified both as a barrier and as a driver, similarly to the findings in the literature and EU projects reviews. The survey confirms these findings both in the social acceptance and market acceptance sections as groups that are involved with the SunHorizon project, and thus have more information about the technology, are found to be more positive towards how the media presents the technology. The information with the highest impact on the stakeholders is the increase of social status, technical performance, the environmental aspects of the technology and the related legal framework.

4. Conclusions

Market acceptance shows significant variations among stakeholders and countries. In all countries, investment cost of the technologies is perceived as a barrier for adoption. In Spain legal and organizational issues are also perceived as barriers, while Latvian and Belgian respondents identified economic and legal barriers. The respondents from Germany only perceived the investment cost as a barrier. Economic aspects are perceived as the main barriers among public building owners and the general public. Businesspersons perceive the largest number of barriers including economic aspects, lack of information, trust, business models and legal issues, while private building owners perceive the least barriers, only related to economic aspects. The results of this work can be used as input for policy makers, as they formulate strategies to foster adoption in Europe.

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