6.7 A User-Centered Design Approach to Identify Behavioral Biases in the Adoption of Solar PV by Households

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1. Introduction

Buildings offer great potential for solar photovoltaics (PV), given that no land-use change is required, the energy is used directly where it is generated, and it activates citizens within the energy system. In contrast, households have under-invested in energy technologies for decades, resulting in policies that force innovations into the market or that rely on economic incentives [1]. Relevant behavioural research predominantly focuses on activities that use energy. However, investments in energy technology have the potential to exert much greater impact on sustainability goals [2,3]. Energy technology adoptions are typically described using Rogers' model of innovation diffusion, where information plays a prominent role in the decision-making process [4]. The timing, source and quality of information have all been identified as critical factors influencing consumer behaviour [5–7]. However, there is a lack of research into the methods of improving information delivery to consumers. Likewise, there is a lack of randomized field trials for testing energy investment behaviour at scale [8,9], which is critical for validating the impact of insights from using laboratory or qualitative methods [10].

2. Objective

This paper describes the first phase of an applied project to improve information delivery to Swedish consumers and nudge them towards adoption of PV. The objective of this study is to identify relevant behavioural techniques for randomized field trials of solar PV investment. The trials will be conducted via web-based commercial tools, their own goal being to increase lead conversion and reduce cost. Therefore, sub-objectives include:

— identifying customers' needs, barriers, motives and misconceptions about PV
— identifying promising methods of information delivery to serve the customer's needs
— mapping PV market stakeholders to ensure robust and successful experimentation.

3. Methodology

The project uses a Design Thinking approach, starting with mapping user journeys to understand behavioural insights in the decision-making process. Twenty-eight semi-structured interviews are being conducted with decision-makers in three ownership categories – villas, multi-family cooperatives and professional property owners. Existing communication channels are reviewed to describe the current state of information delivery in the market and improve the design process for experimentation in light of the required commercial features. The interviews and review combine to reveal specific decision-making contexts and behavioural techniques, which are matched with relevant theories in the scientific literature to form the basis for field trials.

4. Results and Findings

The interviews reveal a wide range of barriers, motivations, triggers, activities and behaviour that span the entire adoption process. However, the focus here is on information acquisition and presentation during the "gaining knowledge" and "forming an opinion" stages [5]. A number of barriers commonly found in the literature are present, such as long payback times, a lack of knowledge about the technology, uncertainties about the technical or economic performance, and difficulties in finding trustworthy information [6,11]. Some unexpected themes also arose, such as a desire to understand PV within the context of other energy options to make investments with the greatest impact. There are also misunderstandings, such as the expectation that PV is rapidly improving (motivating waiting) or that completely avoiding grid sales is a prerequisite for a good economy. This last point made batteries a frequent point of discussion, despite their being uneconomic, and thus leading to the conclusion that PV as a concept is also uneconomic.

PV providers and third parties are increasingly building professional-looking web-based tools that calculate the energy-generating potential of a user's roof, recommend a system, and provide a quotation with some indicators of the financial savings. On the surface, this appears to be valuable information, but many of the tools involved provide simple, limited information, overestimate energy generation and economic gains, and generally present a best-case scenario, sometimes pushing the boundaries of plausibility. There is also a lack of interactivity or transparency such that using the tools to test different options with rapid feedback is difficult, thus limiting the educational value.

The shortcomings of online tools reveal an interesting point of conflict between the motives of customers and of providers: websites can be lures to generate leads and capture customers. The goal is to generate personal consultations where the provider has the customer's full attention, builds trust and can be more personal and therefore effective in their analyses. For the customer, this system requires consulting with multiple suppliers to cross-examine their offers and analyses, though they still lack input from a neutral, trusted source. The state government's energy agency has a PV calculator aimed at educating users, but its inputs do not make it easily comparable with commercial tools, thus reducing its effectiveness as an arbiter.

5. Discussion and Conclusions

Although the Swedish PV market is small, it is growing rapidly, with a disproportionately high number of suppliers. For individual companies trying to build a brand and capture market share, word-of-mouth recommendations and personal connections are a valuable strategy [12]. From the consumers' perspective, this can create an information barrier that prevents them from reaching the implementation stage [4,5]. Several interviewees reported that their receipt of the first offer spelt the end of their investigation into solar PV. While it may not fit into the relationship strategies of individual businesses, a personalized information source focused on educating consumers can lower the barriers to information and reduce information asymmetry, which also lowers transaction costs for the PV industry as a whole [13].

These insights will be valuable in devising new communication strategies and revealing relevant behavioural techniques that may reduce the barriers to users. A fundamental need is to consider information-overload and decision-fatigue, which promote bias towards the status quo. The user's understanding of performance indicators is also important [14], which quantifies their perceived estimate of a PV system (technical, economic, environmental). The framing of PV benefits as savings versus investment is a notable test point, on that will need to consider time-inconsistent preferences such as present bias and hyperbolic discounting. A question of framing also arises where the tool can act as an authority to provide a specific recommendation, or as a dynamic educational tool that allows the user to explore options and receive feedback. Novel probability indicators inspired by finance can also be tested to reduce loss-aversion from economic uncertainties [15,16]. These key insights provide experimentation points that can design randomized field trials to be executed via web-based channels during the second phase of the project.

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