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Original research article

Peer effects in residential solar photovoltaics adoption—A mixed methods study of Swedish users

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ABSTRACT

Neighbourhood peer effects (social influence) in the diffusion of residential solar photovoltaics (PV) have previously been identified and quantified in a number of studies. Yet, little has been known about the inner workings of peer effects in PV diffusion. In the present work, a survey and interviews were used to study peer effects among Swedish PV adopters. Participants acknowledged peer effects as important for their adoption decision, although they had in general been seriously contemplating PV adoption before the effects. The main function of peer effects appears to have been a confirmation that PV works as intended and without hassle, rather than the procreation of unexpected insights or the provision of more advanced information. Peer effects had mainly occurred through existing and rather close social relationships, rather than between neighbours that did not already know each other. Peer effects appear to have reduced barriers related to PV attributes such as low trialability and low observability of the actual results of adoption. The results suggest that passive peer effects (through seeing PV) were less important than active effects (through direct interpersonal contact), and that seeing PV rarely led to direct contact with adopters, a finding that contrast somewhat to previous literature.

1. Introduction

Solar photovoltaics (PV) is a renewable energy technology that converts solar irradiation directly into electricity. PV is highly suitable for micro-scale electricity generation, for example through roof-mounted applications, and PV systems have been increasingly adopted by households around the world. Motivations for PV adoptions by private individuals vary, but in developed countries they relate mainly to reduced energy bills, reduced environmental impact, energy independence and a general interest in new technology [1,2]. Apart from economic performance, factors influencing the adoption decision of homeowners include complexity of rules and administrative procedures [3] and access to alternative ownership models [4]. For various actors to be able to support the diffusion of PV and other sustainable technologies, an enhanced basic understanding of the mechanisms behind their adoption could be beneficial.

Moreover, it has been found that peer effects – the social influence of peers, such as colleagues, neighbours or friends – often play an important role in PV diffusion. Several studies have quantified peer effects in residential PV markets [5–11], mainly in terms of increased likelihood of additional adoptions within a certain geographical unit (e.g. a zip code, a street segment, or within some set distance) as a result of previous adoptions in the area. Such 'neighbourhood peer effects' have been predominantly studied using quantitative approaches, while their underlying mechanisms have remained poorly understood. To increase the understanding of peer effects in residential PV diffusion, this paper uses a combination of quantitative and qualitative research methods. A survey questionnaire was sent by postal mail to Swedish PV adopters, and interviews were performed with responding adopters that reported having been in contact with PV adopters in their neighbourhood prior to taking a final decision to adopt PV. An enhanced knowledge about the inner workings of peer effects in residential PV adoption could prove useful for policy makers, firms, NGOs and other actors aiming to support PV diffusion.

The paper is organised as follows. In Section 1.1, the Swedish PV market and relevant contextual factors are outlined. In Section 2, a review of related literature is provided together with an account of gaps in the previous research that were identified through this review. Section 3 describes the design and execution of the data collection (survey, interviews) and analysis. In Section 4, a detailed account of the results is provided, and these results are discussed in Section 5. Section 6 concludes.

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1.1. PV in Sweden

The Swedish residential PV market is in an early stage of development, but the number of installations has been rapidly growing over the last decade. In 2013 (which marks the end of the time period studied in this paper) less than 0.1% of all Swedish households had adopted a PV system [12]. The number of PV system installers in 2013 was around 70 [13]. PV systems have typically been bought by the adopter, and third-party ownership models that have proliferated in several other market have been very uncommon in Sweden [13].

The yearly production of an optimally oriented PV system in Sweden is normally in the range of 800–1100 kWh per installed kilowatt, depending on the location [14]. The potential for building-sited PV considering Sweden's existing building stock has been estimated to 10–40 TWh/year [15], which corresponds to about 7–30% of the country's current electricity production.

The Swedish PV market has been heavily dependent on an investment subsidy scheme introduced in 2008, through which a fixed percentage of the PV system's cost is covered by a rebate [13]. As a response to decreasing costs of PV technology, the subsidy was stepwise reduced from 60 to 35% of the expenses during the timeframe studied. Investing in a residential PV system has been neither very financially profitable (even with subsidies) nor clearly unprofitable for households during the studied time period [14].

The institutional and economic conditions have been rather uniform throughout the country, which makes the Swedish context suitable for studying the role of other factors influencing PV adoption rates, such as information provision and social influence [16]. Overall, the public policy framework has been nationally uniform, and there have been no subsidies on the sub-national level. National legislation introduced in 2010 obligates all electric utilities to allow homeowners grid connection of their PV systems at no charge, including the installation of any necessary metering equipment [12]. Surplus electricity can relatively easily be sold at (or above) spot prices on the deregulated Swedish electricity market [17], and electricity prices are rather uniform throughout the country [18]. Regional differences in yearly solar influx are relatively small.

2. Related literature

Peer effects are the influence of a person's peers – such as neighbours, co-workers or friends – on his or her behaviour. The importance of peer effects in the diffusion of innovations has since long been recognised [19], and peer effects have been observed in the adoption of such diverse technologies as, for example, menstrual cups among Nepalese adolescents [20], electric vehicles [21], information and communication technologies (ICT) (e.g., [22]), and various farming equipment [19]. Peer effects are often highly localised, which could be due to people living close to each other being more likely to know or communicate to each other, or because neighbours that do not know each other can often observe each other's activities. For example, housing renovations have been found to increase in number as a result of previous renovations nearby [23].

Peer effects can be *active* (involving direct communication with a peer) or *passive* (as someone observes or in some other way becomes aware of the activities of a peer, for example by seeing a new PV installation in their neighbourhood) [9]. Peer effects occurring through positive word of mouth are often important for the successful diffusion of innovations, particularly when the support of a strong brand or strong marketing resources are lacking, which is often the case for small companies marketing radical innovations [24].

A category of people that are particularly important for local peer effects are the *opinion leaders*. These are persons that have a relatively high influence on others' opinion about an innovation. Opinion leadership is thus the ability to informally influence other persons' attitudes or behaviour in a way desired by the opinion leader. Opinion leaders generally have a relatively high social status, a high social participation, and are somewhat more innovative than the average person (but not too much more, as this would make peers look upon them with suspicion) [19]. On the other hand, research on ICT adoption has found that influential peers are not necessarily 'trendsetters', but that their influence derives from their pre-existing relationship with the adopters and from their willingness to share their experiences [22].

2.1. Peer effects for residential PV systems

Peer effects have also been identified in residential PV diffusion, mainly in a number of quantitative studies of U.S and German adopters over the recent years. Bollinger and Gillingham [5] were the first to show that each PV adoption increased the probability of subsequent PV adoptions in the same neighbourhood. Their geographical units studied were Californian zip code areas and street segments, and they found that peer effects were stronger on the street level than for the whole zip code areas, indicating that peer effects wane with distance. Rode and Weber [11], employing an epidemic diffusion model, found significant and highly localised peer effects in Germany. Graziano and Gillingham [7] and Müller and Rode [8] found significant peer effects in Connecticut, U.S., and the city of Wiesbaden, Germany, respectively, using models based on spatial and temporal distance between installations. Graziano and Atkinson [6] found that spatial peer effects mainly operate within twelve months after a new installation and within one mile of the system's location. Peer effects in PV diffusion have also been simulated using a network model to assess the likely success of different policy interventions [25].

Differences in research approaches make comparison of these findings somewhat difficult, but the size of the estimated peer effects in terms of increased probability of new adoptions caused by previous adoptions has been estimated at 15 percentage points per month on the street level and 0.78 percentage points per day on the zip code level [5], while an adoption has been estimated to cause 0.44 new adoptions on the U.S. block group census level [7]. Richter [10] found smaller peer effects for PV in UK zip code areas.

As residential PV systems are in general rather visible, the passive component of peer effects for PV systems (occurring as people observe others' PV systems) has often been assumed to be an important part of the overall peer effects [5,8–11,19,25]. At least one attempt has been made to quantitatively separate between active and passive peer effects, as Rai and Robinson [9] used reductions in the decision periods (time past between the first consideration of adoption and the actual adoption) to represent peer effects in a regression model. Using a survey questionnaire on PV adopters in Texas, U.S., they found that the decision period was shorter among respondents that reported having been influenced by seeing PV systems in their neighbourhood, and (most importantly) among respondents that had been in contact with PV adopters in their neighbourhood. Experiences of peer effects did, in turn (and perhaps not surprisingly), strongly correlate with the (self-reported) number of PV systems in the neighbourhood.

The results of Rai and Robinson regarding the relative importance of passive and active peer effects were, however, somewhat inconclusive. Self-estimated neighbourhood peer effects were associated with a statistically significant reduction in decision period of 4.7 months when holding constant (amongst other) a binary variable for whether or not the respondents had been in contact with a PV adopter in their neighbourhood, thus indicating