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Household installation of solar panels – Motives and barriers in a 10-year perspective

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ABSTRACT

This article compares what homeowners identified as motives and barriers for installing photovoltaic panels in Sweden in 2008–2009 and in 2014–2016. Earlier research has provided snapshots of existing barriers and motives, but not analyzed changes over time, as is done here. Between 2008 and 2014, the PV market in Sweden changed profoundly, with the introduction of subsidies and changes in rules, making it easier for households to sell electricity they produce. At the same time, regulations have increased for the households.

Environmental motives have been consistent over the years. Financial incentives had become an important motive by 2014–2016. The investment cost remained a barrier, even though it has been reduced over the years. New barriers in the second period are problems relating to increased administrative burden and finding information about market conditions such as which companies exist and how much a household will be paid when selling electricity to the grid. In 2008–2009, households installed the PV panels on their own and installation was a major barrier. This had changed radically by 2014–2016, when most of the households studied bought turnkey systems with installation included.

1. Introduction

Rapid growth in the adoption of renewable energy technologies is of great importance for a sustainable future and the number of consumers producing electricity at home, so-called “prosumers” (Toffler, 1980), is rapidly increasing in many European countries. In Sweden too the number of prosumers is increasing. Earlier studies have presented a snapshot of motives and barriers for households to become prosumers, but there is a lack of studies that compare motives and barriers over time. This article will compare how households in Sweden have expressed motives and barriers for installing photovoltaic panels at two different occasions. The first survey was done in 2008–09 and the second in 2014–16. The main question in this article is: Have barriers and motives changed during these years, and if so, how?

The share of photovoltaics (PV) in the Swedish energy mix is not large; it was not even 1% in 2014 (Lindahl, 2015). But it is a market in transition, which makes it interesting to study. Sweden has a lower solar radiation compared with countries more in the south since the maximum insolation angle is only 58 degrees in the far south of Sweden. Still the annual solar influx in the southern half of Sweden is comparable to that in northern Germany and the potential is estimated at 10–40 TWh/year (Muyingo, 2015). Most Swedes live in the southern parts, 88% of the population. Most PV panels are also installed in the south and it is also there the largest expansion can be expected. In a long time perspective the average global solar radiation has increased with about 8% from the mid-1980s until 2016. From about 900 kWh/m^2 in 1985 to 961 kWh/m^2 in 2016 (Lindahl, 2015; SMHI (Swedish Meteorological and Hydrological Institute), 2017). The global radiation differ between the seasons, during the winter 2016 it was 33 kWh/m^2 and during the summer 465 kWh/m^2 (SMHI, 2017). Stridh et al. (2014) calculate that a yield of about 800–1100 kWh/kW per year can be expected during a year with typical solar irradiation for systems with reasonable good azimuth, tilt and without major shading effects. This gives a capacity factor of 9,1–12,6%. The yearly production from an optimally oriented PV system in Sweden is 800–1000 kWh per installed kilowatt (Palm, 2017b).

At the end of 2009, PV had an installed capacity of 8 MW in Sweden (Lindahl, 2014) and most of the installations were off-grid. Since then the market has expanded and at the end of 2014, the installed capacity of PVs had grown to 60 MW (of which 10 MW were off-grid) (Lindahl, 2015). There has also been a change in Swedes’ attitudes toward PVs: it has gone from being seen as a technology for the enthusiast to one that many Swedes can see themselves investing in. For example, a survey carried out by E.ON in April 2016 showed that 73% of respondents (out of 2012 people interviewed) said that they wanted to install PV panels (E.ON., 2016).

Since 2008, I have followed the PV market through different projects, and have interviewed homeowners in Sweden interested in

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investing in PV panels and becoming prosumers (Toffler, 1980). The first wave of interviews were conducted in 2008–2009 and the second wave of interviews in 2014–2016. Analyses of the PV systems used by households often focus on policy, market and financial issues, while issues of motives, social networks, barriers and environmental behavior are not studied (Luthander et al., 2015). The aim of this paper is to highlight the sociotechnical context from the prosumers' viewpoint and to compare how households' motives for and barriers to adopting PVs have changed over the years. The article discuss which motives and barriers have persisted, disappeared or appeared over the period.

This article is structured as follows: the next section discusses earlier research on motives and barrier for PV adoption, followed by a description of the study method and material, comparison of motives and barriers, and conclusions.

2. Earlier research on motives and barriers for PV adoption

Buying a PV system is a high-involvement decision in which households usually invest a lot of time and consideration before making a decision (Jager, 2006). Due to the complexity of the decision people will have far from complete information on the issue and will act in accordance with the theory on bounded rationality. Many different drivers and barriers will be involved in the decision-making process.

In earlier research important drivers have been identified, see Table 1 below. The driver mentioned most often is environmental concerns (Balcombe et al., 2013; Enlund and Eriksson, 2016; Palm and Tengvard, 2011; Wittenberg and Matthies, 2016). Balcombe et al. (2013) however discuss that even if environmental benefit is a significant factor in the decision to install PV for the purpose of microgeneration, this does not necessary mean that households are prepared to pay extra for it. Schelly's (2014) study is based on interviews with 48 people across the state of Wisconsin. The study suggests, in line with Balcombe et al. (2013) that environmental values alone are not enough, and are not always necessary, to motivate adoption of PVs.

Another motivation found in earlier research is to save money by buying less electricity from the grid or selling their own produced electricity. A related driver is to install PVs as protection against future high costs (Balcombe et al., 2014; Enlund and Eriksson, 2016; Islam, 2014; Juntunen, 2014; Palm and Tengvard, 2011; Shwom and Lorenzen, 2012; Wittenberg and Matthies, 2016). The introduction of feed-in tariffs has also increased adoption of microgeneration, for example in the UK (Balcombe et al., 2013, 2014) and Germany (Schaffer and Brun, 2015).

Another identified driver is that someone in the household has a technical interest and wants to try out PV technology. To become self-sufficient in electricity is also mentioned as a symbolic reason, to show others that the family cares about the environment and how energy is produced (Balcombe et al., 2013, 2014; Juntunen, 2014; Palm and Tengvard, 2011; Wittenberg and Matthies, 2016).

In earlier studies peer effects have been highlighted as an important factor for homeowners to invest in PV (see Palm, 2017a for an overview of earlier research). Most studies have however not done any thorough study of peer effects. Palm's (2017a) study did so and he specifically chose to analyze what effects peers such as relatives, friends and neighbors have on the adoption of PVs. The peer effects he finds are mainly that peers function to confirm that PV systems work as intended and without hassle. Peers do not contribute unexpected information or more advanced information. Palm also found that peer effects occurred through existing and close relationships rather than between neighbors that did not already know each other. Passive peer effect (i.e., just seeing PVs) were less important than active effects (through direct interpersonal contact).

Table 1
Summaries of motives in earlier research.

Motives
Testing new technology; technical interests
Increase convenience
Earning money
Cost efficiency
Protecting against future high cost
Environmental benefit
Security of supply
Symbolic reasons
Self-sufficiency
Social networks, peer effects

Table 2
Summaries of barriers in earlier research.

Barriers
Finance; investment cost, long pay-off time
Lack of subsidies
Uncertainty and mistrust that the system will perform as desired
Aesthetic and impact on residence
Hard to find objective experts
Satisfied with existing system
Do not want to change routines
Perceived increase in maintenance
Presence of different opinion within a household
Uncertainty around regulations and subsidies
Technical flaws
Poor compatibility with existing infrastructure
Take place on a small scale
Lack of organizational and institutional support

Barriers or hindrances to adopt PVs have also been studied, see Table 2 for a summary of these. Here financial barriers are most often discussed, involving high investment cost, long pay-off time and lack of subsidies (Balcombe et al., 2013, 2014; Enlund and Eriksson, 2016; Palm and Tengvard, 2011). Acceptable pay-off has been analyzed by Scarpa and Willis (2010) for microgeneration and estimated at 3–5 years, which in a PV perspective is not long. Balcombe et al. (2013) discuss that FIT has reduced pay-off time in UK for PVs to 11 years from 35 to 58 years. This is of course a huge reduction but the pay-off time is still higher than the calculated acceptable pay-off time. Schelly (2014) found however that pay-back periods are less important than the particular timing of economic events within a household. Many used for example inherited money to pay for their solar system or timed their installation to occur just before retirement with the purpose to reduce the electricity bills after retirement.

More barriers mentioned in earlier research are uncertainty and mistrust that the system will perform as desired (Balcombe et al., 2013; Palm, 2017b; Palm and Tengvard, 2011). A perceived increase in maintenance and the complexity associated with a system change is a barrier for adoption. Inconvenience when it comes to major changes in the garden or roof is a barrier. A barrier can also be that you are satisfied with the existing energy system and do not want the inconvenience of changing routines. Microgeneration is seen as a "resistant innovation," since increased uptake requires adopters to considerably alter their daily routines and habits, which represents an inconvenience (Balcombe et al., 2013).

Aesthetics and disapproval from neighbors have been mentioned in some studies (Balcombe et al., 2013; Enlund and Eriksson, 2016; Palm and Tengvard, 2011). Value of the home is not a major issue. Studies on how property values are affected however show conflicting results, sometimes tending to increase and sometimes decreasing or not changing (Balcombe et al., 2013).

The difficulty in finding trustworthy information on microgeneration is also a major obstacle to adoption, particularly for those considering PVs, despite efforts by the government and microgeneration interest groups to reduce this barrier (Balcombe et al., 2013, 2014).

More barriers found are lack of organizational and institutional