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Motivators for adoption of photovoltaic systems at grid parity: A case study from Southern Germany

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ABSTRACT

In some countries, photovoltaic (PV) technology is at a stage of development at which it can compete with conventional electricity sources in terms of electricity generation costs, i.e., grid parity. A case in point is Germany, where the PV market has reached a mature stage, the policy support has scaled down and the diffusion rate of PV systems has declined. This development raises a fundamental question: what are the motives to adopt PV systems at grid parity? The point of departure for the relevant literature has been on the impact of policy support, adopters and, recently, local solar companies. However, less attention has been paid to the motivators for adoption at grid parity. This paper presents an in-depth analysis of the diffusion of PV systems, explaining the impact of policy measures, adopters and system suppliers. Anchored in an extensive and exploratory case study in Germany, we provide a context-specific explanation to the motivations to adopt PV systems at grid parity.

Contents

1. Introduction

Concerns about climate change and limited resources of fossil fuels have prompted governments to support the emergence and diffusion of renewable energy systems. The European Union (EU) has set targets of 20% share of renewable energies in overall energy consumption by 2020 [16]. One of the renewable energy

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sources that is expected to pave the way for achieving this goal is the solar photovoltaic (PV) systems. If all specific boundary conditions are met (e.g., shifting energy policies from conventional electricity generation to renewable energies and the reduction of the levelized cost of PV electricity), it is estimated that solar PV systems will supply up to 12% of the EU electricity demand by 2020 [17]. Germany is in the forefront of solar PV deployment, exhibiting a steady growth until 2011 that made the Germany the most developed PV market in the world, with 24,678 MW of installed capacity [18]. According to some studies (e.g. [39,49,56,10]), solar PV energy in Germany had already achieved grid parity by 2012, i.e., solar PV energy can directly compete with conventional electricity sources in terms of the levelized cost of electricity generation.

The German feed-in tariff scheme is widely accepted as the strongest driver for the diffusion of PV since 2000 [14]. This scheme ensures that solar PV adopters (when they supply electricity to a grid) get paid by fixed feed-in tariffs over 20 years,. However, the feed-in tariff for solar PV systems has decreased more rapidly than that for any of the other renewable energy technologies [61]. Although solar PV systems in Germany are often assumed to be at grid parity, the PV market has recently faced uncertainties related to the cuts in the feed-in tariff. The reduction and the ultimate end of the policy support pose fundamental questions about the diffusion of solar PV systems: how will they be deployed when the feed-in tariff diminishes? What are the motivators to adopt PV systems at grid parity? In the literature, the diffusion of PV technology has been studied regarding the aspects of, first, policy support, including feed-in tariffs [30,32,66], second, adopters' influence [9,43,50,66] and, recently and finally, the role of local solar companies [15,20]. Although some studies have conducted economic analysis of the stage in the deployment of solar PV when grid parity is approaching (e.g. [25,56]), less has been discussed about the adopters' motivations.

Based on an extensive and exploratory case study, the aim of this paper is to extend the debate by providing multiple wealth of empirical details in a context-limited knowledge (suggested by [21,64]). We focus on the diffusion of solar photovoltaic systems and analyze the motivations to adopt PV systems. We frame these motivations associating with the roles of the policy measures, adopters and local solar companies. The case study is based on Hartmann Energietechnik GmbH (HET) in Southern Germany, a leading local solar company that has been engaged in the diffusion of solar PV systems in the region since the early 1990s. Apart from this introduction, this paper is structured as follows. Section 2 develops the analytical framework to be used for interpreting the data. Section 3 explains the research methodology. Section 4 introduces the case study. Section 5 analyses the results of the empirical research and discusses the key motivators for the diffusion process. Finally, Section 6 presents the conclusions and future lines of research.

2. Analytical framework

Diffusion of innovations is a multidimensional process [see e.g. 57,34]. The availability of a new technology or innovation, such as solar PV technology, does not necessarily motivate its adoption by individuals. The perceived attributes of an innovation, which is contingent upon the adopters, explain 49–87% of the variance on the different diffusion rates of different innovations [54,59]. These attributes are relative advantage, compatibility, complexity, trialability, and observability. *Relative advantage* refers to the degree to which an innovation is perceived to be better than the incumbent idea, technology, or practice and is usually expressed as economic profitability. However, non-economic factors (e.g., quality, satisfaction, environmental awareness and social prestige) are also important. This is also the case of the PV diffusion (e.g. [32,45,48]). *Compatibility* is the degree to which an innovation is perceived as being consistent with the existing values (e.g., sociocultural values and beliefs), past experiences (e.g., previously introduced ideas), and the needs of potential adopters. Several studies points to a direct relationship between the compatibility of an innovation and its adoption in the case of PV technology [43,55]. *Complexity* is the degree to which an innovation is perceived as being relatively difficult to understand and use. Generally, there is an inverse relationship between the perceived complexity of an innovation and its adoption rate [33,38,63], as was experienced in the diffusion of solar PV systems [1,32]. *Trialability* is the degree with which an innovation may be experimented on a limited basis. Innovations with high trialability often have a higher diffusion rate [42,54], although some other studies [38,63] indicate an absence of a relationship between trialability and the adoption of innovations in the energy sector. Finally, *observability* is the degree to which the results of an innovation are visible to others. According to Tidd [59], the rate of adoption of an innovation increases when it is easier to see the benefits of this innovation.

As Rogers [54] argues, the decisions regarding adopting innovations can be categorized as optional (where the adopting individual has almost complete responsibility for the decision), collective (where the individual has a say in the decision) and authority (where the adopting individual has no influence in the decision). Because all of these types of decisions center on individuals, there has been some criticism that they do not provide sufficient emphasis on structure, context, or collective action [60]. However, the diffusion process may involve a mix of all of these decision-making types, depending on the type of technology, regulations and adopters, as is the case of the renewable energy technologies in different countries [8,51].

Innovation diffusion requires communication channels by which messages are transmitted from one individual to another [54]. Interpersonal communications (including non-verbal observations) and mass media channels (television and internet) are important influences on the diffusion rate of the innovations in a social system [41,54]. Communication between adopters and the observability of the adoptions can induce peer-effects, whereby the decision of potential adopters may be influenced by the previous adopters [9]. Recent literature has paid much attention to how peer-effects influence the diffusion of PV technology [46,53].

In addition, the variables determining the rates of adoption are influenced by a social system, which is a set of interrelated units that are engaged in joint problem solving to accomplish a goal [54]. The members of a social system may be individuals, informal groups, organizations and/or subsystems. Potential adopters can be influenced to adopt an innovation by the pressure of the social system generated via adopters, public policies, shareholders and organizations [4,22]. Some recent research have identified the effects of network externalities as being significantly important for the diffusion rate of innovations [7,23].

Finally, the diffusion process is boosted by the presence of a change agent, who is an individual that influences the decisions of potential adopters in a direction deemed desirable by a change agency. Rogers [54] identifies the seven roles of change agents as developing a need for change, establishing an information exchange relationship, diagnosing problems, creating an intent to change in the adopter, translating an intent into action, stabilizing adoption (e.g., preventing discontinuance) and achieving a terminal relationship. The PV industry in Germany [13] and wood-fuelled heating systems in Austria [40] indicate that change agents could vary, depending on the context and innovations: local companies, architects, foresters, non-profit organizations and banks.