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Title

Diffusion of Photovoltaic in Germany: Policy vs. Consumers

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Abstract
In some countries photovoltaic (PV) technology has already achieved a stage of development at which it can compete with conventional electricity sources. Germany provides a good illustration of this where PV market has reached a mature stage. As a manifest of this, the German government has recently reduced subsidies for households and industry by decreasing the feed in tariff for PV. This development raises fundamental questions: could the PV industry survive? Will consumers be motivated to continue to adopt PV when feed-in tariff diminish? The point of departure for the relevant literature on diffusion of PV has been on the effect of subsidies but little attention has paid to consumer motives when the policy support is scaled down. This paper introduces an in-depth analysis on understanding the consumer motives for adopting photovoltaic applications. Anchored in an extensive exploratory case study on PV consumers and PV system providers, this study aims to provide an encompassing explanation of diffusion of PV by revealing the link between consumer motives and the impact of policy.

Keywords
Diffusion of Innovations, Policy, Photovoltaic.

Extended Abstract:

Concerns about climate change and offsetting greenhouse gas emissions has promoted countries to subsidize renewable energy. For instance, countries of the European Union (EU) have set targets of 20 percent for decarbonisation of the energy sector by 2020 through renewable energy technologies (EP, 2009), such as Photovoltaic (PV), a technology that converts electricity from sunshine. If all specific boundary conditions are met (e.g. shifting energy policies from conventional electricity generation to renewable energies and the reduction of PV production costs and prices), it is estimated that PV will supply up to 12% of EU electricity demand by 2020 (EPIA, 2012a; Greenpeace & EPIA, 2011). Germany already presented a steady growth for a decade as the most developed PV market in the world with 24,678 MW total installations (EPIA, 2012b). While PV diffusion in Germany is at a stage that can compete with conventional electricity sources (Lettner & Auer, 2012), the market for PV is currently facing a little boom and bust cycles through the recent cuts on feed-in tariff. However these latest cuts on German feed-in tariff can be perceived as a testimony that PV technology has matured and hence should be treated like other conventional generators (Fulton, Capalino, & Auer, 2012). In this regard, a question that gains importance: What happens on the demand side? What are the motivating factors for consumers when feed in tariff diminishes?

In the last decades, the diffusion of photovoltaic technology has been studied from different theories and perspectives including fundamental human needs theory (Max-neef, 1992), diffusion of innovations theory (Rogers, 2003), technological innovation systems perspective (B Carlsson & Stankiewicz, 1991) and ecological modernization approach (Jänicke, 2008). The studies have revealed the impact of policy in terms of financial and promotional support (Jager, 2006), the importance of politics governing energy transformation (Jacobsson & Lauber, 2006) and the role of regional policy subsidies (Zhang, Song, & Hamori, 2011). The factors triggering consumers to adopt PV have also been widely studied and identified as geography, religion, education, ethnicity, social capital (McEachern & Hanson, 2008), peer effect (Bollinger & Gillingham, 2012), sunshine duration, housing investment, environmental awareness (Zhang et al., 2011), experience, knowledge, familiarity (Peter, Ramaseshan, & Nayar, 2002), installation costs (Peter et al., 2002; Zhang et al., 2011) and local initiatives (Dewald & Truffer, 2012). However, the link between policy support and customer motives still remains unsolved, especially in the case of reduction of subsidies.

This paper introduces an in-depth analysis of customer motives for adopting photovoltaic applications. It aims to discuss the link between customer motives and policy decision to reduce incentives. Methodology is based on an extensive and exploratory case study (Yin, 2003) of consumers and a system provider firm in Southern Germany. This firm is a leading initiative which witnessed the diffusion of photovoltaic from the 1990s in the region. The choice of case study as a method is based on the fact that it provides us with an opportunity to gain in-depth insights into an empirical phenomenon which we can develop theory implications inductively. Given the insufficient theoretical link between policy and costumer motives on photovoltaic diffusion, we present a theoretical framework reflecting existing theories and perspectives such as Theory of Diffusion of Innovations (Rogers, 1962, 2003), Multi Level Perspective (Geels, 2002), Complex Systems (Rotmans & Loorbach, 2009), Lead Markets (Beise & Rennings, 2005; Jacob, Beise, Blazejczak, & Edler, 2005), Innovation Systems (Asheim & Coenen, 2005; Bo Carlsson, Jacobsson, Holmen, & Annika, 2002; Malerba, 2002) , Utility Theory and Experience & Learning Curves. This theoretical framework has not only established the research gap but also is used as a springboard for interpreting the data later.

In the framework of this case study, one of the researchers is located at a system's provider firm in southern Germany and given access to study the firm's interaction with customers for three months (winter 2012-2013). The main data source is face-to-face interviews with consumers and employees of the firm. Units of analysis are individuals and their decisions. The data is

triangulated with other data including additional interviews from partner firms, observations made in the firm, communication between customers and the firm, and PV feed in tariff history. All interviews are semi-structured with open end questions. The duration of interviews varied between 10 minutes to 1 hour and the total number of interviews are 18. The purpose of interviewing both consumers (demand side) and employees in the firm (supply side) is to deepen the understanding of the context of diffusion of PV. The respondents from the demand side include the consumers that adopted PV in the year of 2012, the year that the German feed-in-tariff was cut rapidly. The respondents from supply side include technical and marketing employees who have interactions with consumers of both PV and other alternative renewable technologies provided by the firm (solar thermal energy and biomass). All the interviews were transcribed, translated and analyzed to capture the main motives of PV consumers.

The preliminary results show that, apart from the factors that have already been studied in the literature, first, "design" is an important factor that triggers consumers to adopt PV. Design of a PV system can differ from other PV applications not only aesthetically but also through its functionality. As the current PV industry offers already different PV solutions, e.g integrated roof solutions (a concept where PV is used instead of roof material), façade systems (a system for using PV on facades) or self-consumption PV solutions (a concept based on electricity storage and self usage), it is interesting to understand whether one of any types can become a dominant design (Utterback, 1994) or disruptive innovation (Christensen, 1997) in PV market. The role of design can be also shaped by policy and subsidies. For example, German policy makers could influence the birth of dominant design or disruptive innovation of PV industry only if they distinguish between the different types of PV in feed-in tariff (e.g. enforcing higher feed-in tariff for integrated roof solutions as it happens in France).

In conclusion, this paper contributes to the understanding of the link between consumers' motives for PV applications and policy implications on PV diffusion. This study is unique in terms the case studied and the theoretical framework which includes various theories from different disciplines. For future work we will finalize our data analysis, and therefore give more insights about the motivating factors for PV consumers when feed in tariff diminishes.

References

Asheim, B. T., & Coenen, L. (2005). Knowledge bases and regional innovation systems: Comparing Nordic clusters. *Research Policy*, *34*(8), 1173-1190. doi:10.1016/j.respol.2005.03.013

Beise, M., & Rennings, K. (2005). Lead markets and regulation: a framework for analyzing the international diffusion of environmental innovations. *Ecological Economics*, *52*(1), 5-17. doi:10.1016/j.ecolecon.2004.06.007

Bollinger, B., & Gillingham, K. (2012). Environmental preferences and peer effects in the diffusion of solar photovoltaic panels. *Fortcoming in Marketing Science*.

Carlsson, B, & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Evolutionary Economics*, 93-118.

Carlsson, Bo, Jacobsson, S., Holmen, M., & Annika, R. (2002). Innovation systems: analytical and methodological issues. *Research policy*, *31*, 233-245.

Christensen, C. M. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business School Press, Cambridge, MA.

Dewald, U., & Truffer, B. (2012). The Local Sources of Market Formation: Explaining Regional Growth Differentials in German Photovoltaic Markets. *European Planning Studies*, *20*(3), 397-420. doi:10.1080/09654313.2012.651803

EP. (2009). Directive 2009/28/EC of the European Parliment and the Council of the 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subswquently repealing Directives 2001/77/EC and 2003/30/EC. *Official Journal of the European Union*, 16-62.

EPIA. (2012a). *Connecting the sun, Solar Photovoltaics on the road to large-scale grid integration*.

EPIA. (2012b). *Global Market Outlook for Photovoltaics until 2016*.

Fulton, M., Capalino, R., & Auer, J. (2012). *The German Feed-in Tariff: Recent Policy Changes*.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, *31*(8-9), 1257-1274. doi:10.1016/S0048-7333(02)00062-8

Greenpeace, & EPIA. (2011). *Solar photovoltaic electricity Solar generation 6, Solar photovoltaic electricity empowering the world*. Brussels, Belgium & Amsterdam, Netherlands: European Photovoltaic Industry Association (EPIA) and Greenpeace.

Jacob, K., Beise, M., Blazejczak, J., & Edler, D. (2005). *Lead markets for environmental innovations*.

Jacobsson, S., & Lauber, V. (2006). The politics and policy of energy system transformation-explaining the German diffusion of renewable energy technology. *Energy Policy*, *34*(3), 256-276. doi:10.1016/j.enpol.2004.08.029

Jager, W. (2006). Stimulating the diffusion of photovoltaic systems: A behavioural perspective. *Energy Policy*, *34*(14), 1935-1943. doi:10.1016/j.enpol.2004.12.022

Jänicke, M. (2008). Ecological modernisation: new perspectives. *Journal of Cleaner Production*, *16*(5), 557-565. doi:10.1016/j.jclepro.2007.02.011

Lettner, G., & Auer, H. (2012). *Realistic roadmap to PV grid parity for all target countries*.

Malerba, F. (2002). Sectoral systems of innovation and production. *Research policy*, *31*, 247-264. Retrieved from http://www.sciencedirect.com/science/article/pii/S0048733301001391

Max-neef, M. (1992). Development and human needs. *Real Life Economics : Understanding Wealth Creation* (pp. 197-214).

McEachern, M., & Hanson, S. (2008). Socio-geographic perception in the diffusion of innovation: Solar energy technology in Sri Lanka. *Energy Policy*, *36*(7), 2578-2590. doi:10.1016/j.enpol.2008.03.020

Peter, R., Ramaseshan, B., & Nayar, C. . (2002). Conceptual model for marketing solar based technology to developing countries. *Renewable Energy*, *25*(4), 511-524. doi:10.1016/S0960-1481(01)00080-5

Rogers, E. M. (1962). *Diffusion of Innovations*. New York: The Free Press.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th Editio.). New York: The Free Press.

Rotmans, J., & Loorbach, D. (2009). Complexity and Transition Management. *Journal of Industrial Ecology*, *13*(2), 184-196. doi:10.1111/j.1530-9290.2009.00116.x

Utterback, J. M. (1994). *Mastering the dynamics of innovation: How companies can seize opportunities in the face of technological change*. *Long Range Planning* (Vol. 29). Boston, Massachusetts: Harvard Business School Press. doi:10.1016/S0024-6301(97)82840-3

Yin, R. K. (2003). *Case Study Research: Design and methods*. Thousand Oaks: Sage Publications.

Zhang, Y., Song, J., & Hamori, S. (2011). Impact of subsidy policies on diffusion of photovoltaic power generation. *Energy Policy*, *39*(4), 1958-1964. Elsevier. doi:10.1016/j.enpol.2011.01.021