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Solar Community Organizations and active peer effects in the adoption of residential PV

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HIGHLIGHTS

- New dataset on Solar Community Organizations (SCOs) in the U.S. during 1970–2012.
- Shock events catalyze formation of SCOs.
- SCOs-driven peer effects found to positively impact PV adoption.
- Leveraging trust networks is crucial for the success of SCOs.
- In addition to information provision, financing options also key for SCOs′ success.

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ABSTRACT

Solar Community Organizations (SCOs) are formal or informal organizations and citizen groups that help to reduce the barriers to the adoption of residential solar photovoltaic (PV) by (1) providing access to credible and transparent information about the localized benefits of residential PV and (2) actively campaigning to encourage adoption within their operational boundaries. We study the peer effect, or social interaction, process catalyzed by SCOs to understand the impact of these organizations on the residential PV market. Using a standardized search methodology across spatial scales (state; city; neighborhoods), we identify and characterize the operations of 228 SCOs formed in the U.S. between 1970 and 2012. We also present case studies of four successful SCOs and find that a common thread of why these SCOs are successful involves effectively leveraging trusted community networks combined with putting together a complete information and financial-tools package for use by interested communities. Finally, our findings suggest that empirical studies that attempt statistical identification and estimation of peer effects should pay close attention to the role of SCOs, as the social interactions engendered by SCOs may be correlated both with the level of social learning and the socio-demographic characteristics of the communities of interest.

1. Introduction

Information flow through peer effects and social networks are known to impact the diffusion of innovations (Banerjee et al., 2012; Cox et al., 2007; Rogers, 2003; Stern, 1992; Wilson and Dowlatabadi, 2007). Role of these information channels is even more profound for *experience goods*[1] in general (Nelson, 1970; Rogers, 2003; Stern, 2000; Wilson and Dowlatabadi, 2007), and particularly critical for technologies that require high upfront capital (Bollinger and Gillingham, 2012; Narayanan and Nair, 2011; Nelson, 1970; Rai and Robinson, 2013). Because some of the key innovations in alternative energy such as plug-in electric vehicles (PEVs) and solar photovoltaics (PV) are capital-intensive technologies, a better understanding of the underlying channels of information flow could provide insights for overcoming some inherent barriers to the broader diffusion of these technologies. In this paper we focus on the role of community or non-profit organizations in catalyzing peer effects and other forms of information dissemination in the residential PV sector in the United States.

The residential PV market in particular is of interest for a number of reasons. First, the residential sector accounted for 36.9% of total electricity end-use in the U.S. in 2011 (EIA, 2012), thus making it one of the key targets for reducing both electricity

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[1] Experience goods are goods for which key information on quality and performance can generally be obtained only through a (typically) costly search process often involving actually purchasing and using the good. Nelson (1970) showed how the difficult and costly nature of the process of obtaining information for experience goods impacts monopoly power in consumer industries.

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demand and greenhouse gas (GHG) emissions (U.S. DOE, 2012). Second, despite significant growth in recent years, in the first 9 months of 2013 solar energy (including solar thermal and PV) accounted for 0.2% of net electricity generation in the U.S. electric power sector (EIA, 2013). That previous residential solar installations represent only a fraction of the total market potential suggests that the residential market remains a key area for growth for the U.S. solar industry. Third, rates of residential PV adoption remain highly uneven between different states. California and Arizona rank 1st and 3rd in cumulative solar electric capacity, a fact consistent with the high solar resource potential of the southwestern United States (GTM Research, 2012a). However, New Jersey, a state with low comparative resource potential, ranks 2nd in cumulative installations while Texas, with high solar resource potential, ranks 13th and Oklahoma does not rank even in the top 25. These discrepancies reflect both (a) the importance of state and local policies to provide information and incentives that reduce barriers to adoption and (b) the complexity of solar project financing in different electricity markets, which in turn is largely a reflection of the differences in these jurisdictions on regulatory/policy aspects of solar, including interconnection and permitting rules, local rebate programs, and whether solar leasing is allowed. On the positive side, the price of residential PV has been declining rapidly in recent years, leading to escalating rates of installation: Q1 2013 saw a 53% increase over Q1 2012 installations, while average residential installation price fell below $5/W as compared to approximately $10/W in 2007 (Barbose et al., 2012; GTM Research, 2013). In more mature solar markets such as Germany, where generous feed-in tariffs and standardized permitting and interconnections processes have brought higher adoption rates and more retail competition, the total cost of installation is approximately half of that in the U.S. (Renewables International, 2012; Seel et al., 2013). As such, there is significant potential for PV prices to fall even further in the U.S. as balance of systems (BOS)[2] costs begin to decline (Feldman et al., 2012; Goodrich et al., 2012; GTM, 2012b; Rai et al., 2014).

Moreover, there is evidence of broad public support for solar power across all states and political parties (Gallup, 2013; SEIA, 2012). A poll conducted by Hart Research in September 2012 assessed public opinion regarding solar as an energy resource (SEIA, 2012). Based on a national survey of 1206 registered voters across both political parties, the study found that solar energy enjoys a high level of support relative to other generating resources. Ninety-two percent of respondents indicated that it was very important (58%) or somewhat important (34%) for the U.S. to develop and use solar power—higher than for any other resource. Respondents also put solar at the top of the list of resources the government should support through financial incentives with 64% of respondents agreeing, compared to 57% for wind, 38% for hydropower, 32% for geothermal and lower rankings for all fossil-based energy sources. A majority of respondents, however, also indicated that they viewed solar energy as too expensive for most consumers (66%) and not practical in many areas of the country (54%).

The results from this poll provide a useful heuristic for gauging the current state of the residential PV market. While a large number of citizens view solar energy with strongly positive opinions, a variety of factors continue to prevent citizens from becoming adopters of PV. A number of studies mirror this conclusion and suggest that the rate of PV diffusion is a function of both high upfront costs (and lack of adequate financing) and non-monetary costs such as a lack of easily-accessible, credible information (Margolis and Zuboy, 2006; Rai and Robinson, 2013; Shih and Chou, 2011). Consequently, the adoption-decision process for a consumer itself involves considerable investment in both capital and time. As such, insights into the process by which consumers make the decision to adopt (or not to adopt) solar and the mechanisms that effectively address existing barriers to adoption can be useful for policy-makers, industry marketers, and non-profit groups who wish to grow the residential PV market by reducing barriers to adoption.

In this paper, we focus on the activities of community-based organizations that are engaged in the residential solar PV market. We define these Solar Community Organizations (SCOs) as *formal or informal organizations or citizen groups engaged in activities explicitly designed to encourage the adoption of residential rooftop solar PV*. These organizations, due to the heterogeneous nature of their structure and formality, may act as either a change agent or an opinion leader (or both) by providing information and advice about overcoming localized barriers to purchasing and installing solar PV.[3] This includes the dissemination of expert knowledge (often from previous adopters) about project financing and incentives, product and installer reliability, system performance and maintenance, and other uncertainties that may lengthen the period of time needed for a potential adopter to reach a decision. This is distinct from other types of organizations and campaigns that also operate in the residential solar market, such as community solar farms or gardens that attempt to pool capital among residents for group purchasing of a solar array at a separate location. It also excludes marketing programs of private entities (e.g. retail installers), incentive programs or other resources provided by public entities (e.g. municipal or state rebate programs), organizations engaged in programs that do not specifically target residential solar PV consumers (e.g. an advocacy organization lobbying Congress), and organizations that do not include the promotion of residential solar PV adoption as an explicit component of its mission (e.g. a regional economic development council). With this limited scope of definition for SCOs, in this paper we analyze the activities and characteristics of SCOs most associated with the successful facilitation of residential PV adoption. Our analysis is based on a new dataset of SCOs we have built based on a standardized search methodology and four case studies, including semi-structured expert interviews and additional supporting data from reports, news items, white papers, and case-specific data.

Strong public support for solar energy reflects the perception that diversity in fuel sources is required for enhancing energy security or that an energy transition from fossil fuels to lower emission generating sources is required to mitigate the environmental consequences of GHG emissions (Gallup, 2013). Further, for early adopters that have installed solar energy at least in part for its environmental benefits, additional value can be gained by convincing other individuals to also reduce their consumption of fossil fuels by adopting solar (VoteSolar, 2013). Accordingly, we expect to find that the elevation of public concern over climate change in the past decade has led to a proliferation of community organizations formed in support of solar energy.

On the aggregate, we expect SCOs to form where the underlying conditions enable them to meaningfully impact the rate and scale of residential PV adoption. In other words, like any other organization, SCOs have a set of objectives and limited resources to meet them. So SCOs, on the average, would try to locate in places

[2] "Balance of system" (BOS) is defined as "all components other than the mechanism used to harvest the resource (such as photovoltaic panels)," including "design, land, site preparation, system installation, support structures, power conditioning, operation and maintenance, and storage" (*Glossary of Energy-Related Terms*. Retrieved October 12, 2012, from Office of Energy Efficiency and Renewable Energy, US Department of Energy: http://www1.eere.energy.gov/site_administration/glossary.html).

[3] In *Diffusions of Innovations* (Rogers, 2003), Everett Rogers defines an opinion leader as a member of a social system in which they exert influence, and a change agent as an individual who influences innovation-decisions in a direction deemed desirable by a change agency in a more professional capacity.

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