Using Machine Learning and Data Analysis to Improve Customer Acquisition and Marketing in Residential Solar

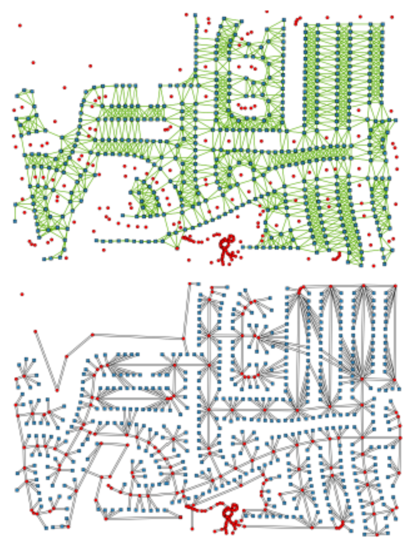
High customer acquisition costs remain a persistent challenge in the U.S. residential solar industry. Effective customer acquisition in the residential solar market is increasingly achieved with the help of data analysis and machine learning, whether that means more targeted advertising, understanding customer motivations, or responding to competitors. New research by the National Renewable Energy Laboratory, Sandia National Laboratories, Vanderbilt University, University of Pennsylvania, and the California Center for Sustainable Energy and funded through the U.S. Department of Energy's Solar Energy Evolution and Diffusion (SEEDS) program demonstrates novel computational methods that can help drive down costs in the residential solar industry.

Photo by Dennis Schroeder, NREL 45243

The emergence of digital media, search engines, and online social networks has opened up tremendous opportunities for solar marketers to generate leads and engage existing customers. Many companies have adopted a mixture of these innovative channels with traditional ones, such as TV, direct mailing, and door-to-door marketing, to generate more sales, strengthen customer relationships, and achieve a higher customer-retention rate. Determining the optimal mixture of marketing channels has traditionally been a complex enough problem that, despite the benefits, few solar marketers have found it practical to do so. With this in mind, SEEDS researchers[1] have developed a novel and powerful budget optimization framework for marketers that can dramatically simplify these optimizations and bring clarity to decision making. The researchers have validated their algorithm by using experimental evaluations to demonstrate the effectiveness as compared to previous best-in-class methods.

Door-to-door selling, or canvassing, is an important sales channel in the residential market because it allows installers to make personal connections with their customers. However, installers also consider canvassing one of the most expensive methods of generating leads due to the large amount of labor needed to canvas every home in a neighborhood. But what if installers could more intelligently plan their canvassing routes based on prior knowledge of which households might be more interested in solar or by their proximity to existing adopters? SEEDS researchers have developed a new algorithm that plots optimal routing paths for marketers. This algorithm significantly outperforms current best-in-class methods. If implemented by solar marketers, this new algorithm[2] could significantly improve lead generation rates and reduce customer acquisition costs.

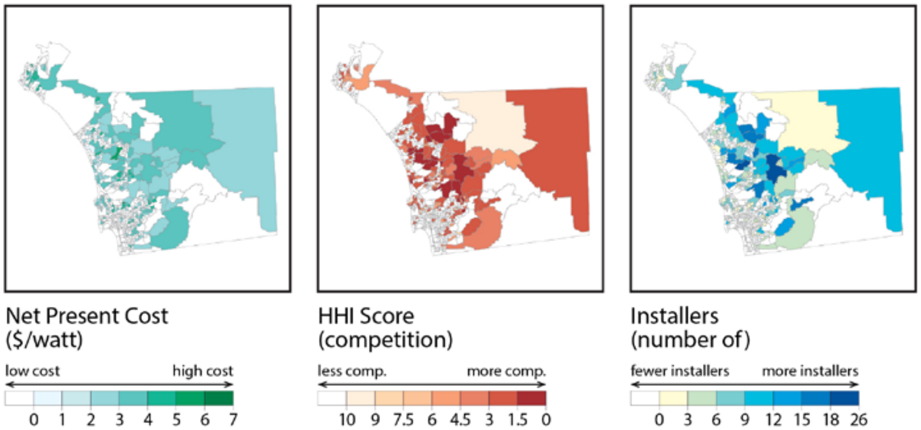
For any company, setting customer prices is a key decision. Low prices can increase growth, but reduce profitability; high prices risk losing sales to competition and lower overall demand. Microeconomic theory suggests that competition leads to lower prices, but this is not universally true. For example, brand loyalty could result in consumers accepting higher prices for an otherwise identical product. New SEEDS research[3] indicates that, in the early years of the San Diego residential solar market, lack of competition actually led to lower prices for consumers leasing solar panels. Firms might have been conducting entry deterrence strategies—setting low prices to gain market share. Alternatively, there could have been a group of dominant firms that occasionally engaged in "price wars."



A hypothetical neighborhood with a social influence network arising from geographic proximity (top) and the corresponding canvasing route (bottom).

As the residential solar market continues to grow, it prompts new questions about the nature of competition between solar installers and how this competition, or lack thereof, affects the prices consumers pay. Though U.S. solar markets have generally

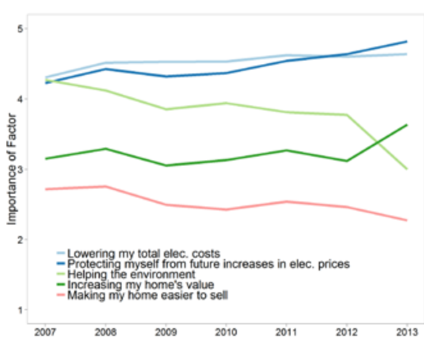
[1] http://www.aamas2017.org/proceedings/pdfs/p1232.pdf
[2] http://vorobeychik.com/2016/gcb.pdf
[3] http://www.nrel.gov/docs/fy17osti/66784.pdf



Spatial trends in residential photovoltaic system costs, competition, and installer concentration in San Diego in 2012.

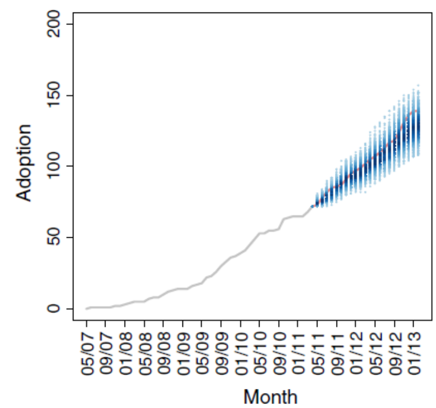
become more competitive over time, resulting in lower prices, these findings suggest that the transition from early to mature markets might be bumpy.

As the U.S. residential solar market expands, marketers will need to adjust their sales tactics to account for a shifting customer base. The history of how new technologies evolve tells us that early adopters tend to adopt new technologies for their novelty and are more forgiving of technological imperfections. Later adopters are more skeptical and require clear evidence the technology will improve their lives. To understand better what customers want and where the residential solar industry might be heading, SEEDS researchers conducted surveys of both solar adopters and non-adopters in San Diego[4]. They confirmed that as solar technology evolves, it is attracting a different set of demographics—early adopters tended to adopt primarily for environmental motivations, while later adopters tended to value the financial savings and hedge that solar provides against rising electricity prices. Moreover, these later adopters also tended to be more representative of general homeowners. They are more likely to be middle-class and more politically moderate. These findings demonstrate how solar markets are evolving, reflecting changes in the underlying drivers of consumer adoption as well as how successful solar marketing can adapt.



Evolution of importance in factors leading to solar adoption.

Accurately predicting the adoption of solar is a hard problem, as the decision to adopt is often idiosyncratic. Breakthroughs in adoption prediction would not only be significant for the solar industry—reducing their customer acquisition costs—but also for system operators, who struggle to predict where and how much solar capacity will be installed each year. Fortunately, new SEEDS research[5] has demonstrated a promising method of predicting adoption using agent-based modeling (ABM), which is a computational method used for studying the complex system properties that emerge from individual interactions. While ABMs are often not developed explicitly for prediction, the SEEDS researchers successfully trained their model using machine-learning methods on actual records of solar adoption in San Diego. The authors not only demonstrated that the model successfully forecasts solar adoption trends, but that it also provides a meaningful quantification of uncertainty about its predictions. Confident of the validity of the baseline forecast, the researchers then used the model to explore how existing financial incentive programs could be better designed to spur additional deployment for the same cost. Intriguingly, they find that policies that 'seed' areas with low levels of adoption by giving away free systems would be significantly more effective than the traditional 'first-come-first-served' design.



Observed average adoption trend compared to the spread of sample runs of the predictive model, with heavier colored regions corresponding to a higher density of adoption.

This work is supported by the U.S. Department of Energy's SunShot Initiative. The analysis is based on projections, estimates, or assumptions made on a best-effort basis, based upon present expectations. Learn more at energy.gov/sunshot.

Contact

Benjamin Sigrin, *benjamin.sigrin@nrel.gov*

[4] *http://iopscience.iop.org/article/10.1088/1748-9326/10/8/084001*

[5] *http://vorobeychik.com/2016/abmsolar.pdf*

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

NREL/FS-6A42-70077 • September 2017

NREL prints on paper that contains recycled content.

Sandia National Laboratories

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND2017-9562 M