MASTER IN ENERGY MANAGEMENT AND SUSTAINABILITY

MASTER THESIS
carried out at Paul Scherrer Institut (PSI) – Villigen, Switzerland

Assessment of long term solar PV diffusion in Switzerland

Agent-based diffusion model for single family houses

August 28, 2015

Supervisors:
Prof. Matthias Finger (MIR)
Dr. Evangelos Panos

Author:
Stavroula Margelou

Abstract

Shortly after the Fukushima disaster in 2011, the Swiss Government decided to gradually phase out of nuclear energy. This decision was coupled with the adoption of a challenging national energy strategy (Swiss energy strategy 2050), which among others focuses on increasing the non-hydro renewable electricity production. Among the options, solar photovoltaics (PV), shows a significant potential it also enjoys high social acceptance. This study investigates the decision to adopt the PV technology at a residential level according to four major criteria: the economic profitability of the investment, the environmental benefit, the income level of the household and the impact of the social networks; the so-called "neighboring effect". To this extent, an agent-based model is developed, including agents that represent single-family houses located at all cantons of Switzerland and classified into several demographic and socio-economic categories. The decision of each agent is stochastic, it is obtained by suitable fitted probability distributions and it is evaluated upon the above mentioned criteria. The scope of the study is to forecast the future PV residential deployment and provide the drivers which affect the most in the adoption decision. Therefore, several scenarios are examined, representing different regulations and policies that support solar PV penetration, as well as sensitivities on technical and economic prospects of solar panels. In addition, the model quantifies the uncertainty surrounding the decision of an agent to install a solar PV system by running with different synthetic populations. In the present study, we test this concept by creating six different synthetic populations of the agents, based on Monte Carlo simulations with probability distributions fitted from real data. However, we don't provide quantification of the uncertainty in terms of variance and other moments, because of the limited number of synthetic populations.

The results show that the economic and the income criteria have the biggest influence on the decision of installing or not a solar PV system, especially in the near-term period, while the effect of the social network accentuates towards the end of the forecast horizon. The analysis also suggests that the cumulative number of adopters and consequently the total installed solar PV capacity in single family houses do not vary significantly between the best and the worst scenario. However, the underlying policies and technical progress significantly affect the timing of the investment. This means that better scenarios lead to faster diffusion of the technology and are to be preferred for a successful implementation of the challenging Energy Strategy 2050. Expanding this work to all potential adopters (including industrial, commercial and multi-family houses, markets) will give more insights on the diffusion of solar PV and will lead to more accurate predictions and testing of new regulations. It should be noted that in designing and implementing the model we didn't conduct specific surveys among the private investors, but we relied on publicly available studies and data. At the same time, we do not go below the cantonal level in terms of spatial resolution. These two limitations should be taken into account when interpreting the results of this study and they constitute two important extensions for future research work on this topic. Another important extension could be the application of the model to more than six synthetic populations.