# Influence of distribution tariff structures and peer effects on the adoption of distributed energy resources: an agent-based modelling approach

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## Overview

Advances in electricity generation and storage technology, as well as in Information and Communication Technology (ICT), have led to a rapid increase of prosumers. The emergence of prosumers raises a series of challenges that cut across technical [1], social [2], and institutional dimensions [3]. In the institutional realm, for instance, the use of distribution tariff structures such as net-metering can cause unintended effects such as cross-subsidization amongst electricity consumers [4]. Therefore, the emergence of prosumers calls for a revision of distribution network tariff design to ensure efficient network utilization and optimal customer response.

This article aims to investigate the influence of different distribution tariff structures and peer effects on both residential consumers' DERs adoption. To achieve this goal, we developed an agent-based taking into account the influence of both economic (e.g., payback period and income level) and non-economic (e.g., peer pressure) factors on the DERs adoption. The model also takes into account the interaction among consumers by incorporating peer effects and for the diversity among actors. This diversity is modeled by specifying the social class and their willingness to adopt new technologies. Finally, the model endogenously considers the interplay between the DERs adoption and the network tariff evolution.

## Methods

The conceptualization of the energy system at the neighborhood level as a socio-technical system is presented in **Figure 1**. The system is analyzed from the perspective of a regulator/policy maker. This system comprises social network(s) and physical network(s). The social network consists of residential end-users. These actors are classified based on types of adopters (i.e. innovators, early adopters, early majority, late majority, and laggards) and income class (high, middle, and low). The physical network consists of technical elements such as the distribution grid, solar panels, batteries, and electrical loads. Actors interact through the social and physical networks, which are governed by intentional relationships (e.g. legislation, property rights, codes of conduct) and by causal relationships (e.g. Kirchhoff's law), respectively. Social interaction occurs through peer-effects among neighborhood residents. It is assumed that the behavior of the system is driven by external factors, including battery and solar panel costs, wholesale electricity prices, and electric loads.

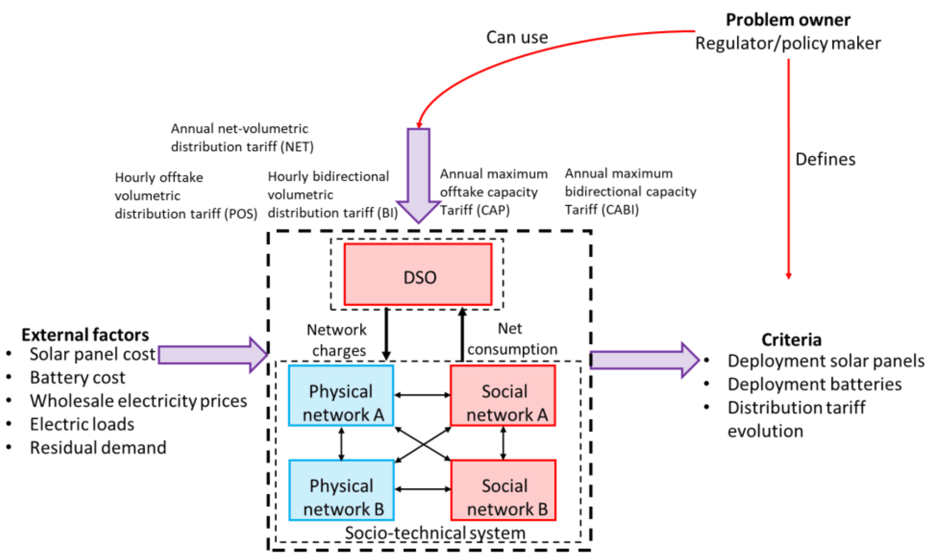

**Figure 1.** Conceptual model

## Results

**Figure 2** shows that PV adoption patterns vary depending on the distribution tariff structure. It can also be observed that, for all different distribution tariff structures, the use of a rational decision-making model led to a rapid solar PV adoption, under all cost and model assumptions taken.

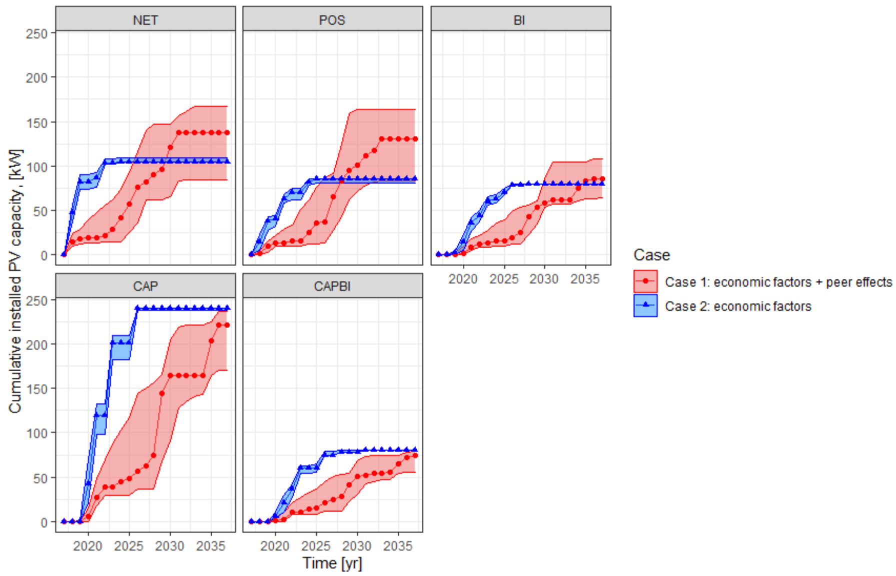


**Figure 2.** Evolution of the PV installed capacity under different distribution tariff structures. NET: annual net-volumetric distribution tariff; POS: hourly offtake volumetric distribution tariff; BI: hourly bidirectional volumetric distribution tariff; CAP: annual maximum offtake capacity tariff; CABI: annual maximum bidirectional capacity tariff. Solid lines represent median values, the shaded areas represent the 90 confidence intervals

## Conclusions

The results highlight the importance of considering the interaction of institutional, economic, and social factors in the analysis of the technological adoption phenomenon. The main insights are summarized as follows:

- The creation of channels of communication enhancing the influence of peer effects on the adoption process may significantly accelerate DERs adoption in the short-term.
- Distribution tariff structures can influence DERs adoption patterns.

From a methodological viewpoint, our study applies a number of key enhancements to prior studies. First, it endogenously considers the interplay between the DERs adoption and distribution tariff evolution, as well as the interplay between residential consumers and prosumers. Second, it incorporates the effect of social and attitudinal components into residential consumers' decision-making on DERs adoption. Furthermore, this study provides evidence of how a system thinking approach in combination with agent-based modeling provide further insights into the households DERs adoption. Given the complexities of an electricity system where the consumer is at the center, we recommend that regulators and distribution system operators adopt a whole system approach to managing the electricity system

## References


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