ABM Project Proposal - Group 16

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Household renewable energy adoption

Abstract

As climate change becomes a more pressing global issue, switching to renewable energy sources like solar panels is more important than ever. In this study, we explore how government subsidies can help increase the adoption of solar panels in cities, especially in neighbourhoods with different income levels. To do this, we use an agent-based model that simulates a city where each household is represented as an agent making its own decisions.

Each household in the model has a few key traits that influence whether it decides to install solar panels or not: income level, how environmentally conscious it is, how resistant it is to social influence (which we call "stubbornness"), and what kind of home it lives in. We distinguish between standalone houses and apartment buildings, since installing panels in apartments is often more complicated due to shared spaces and limited roof access.

We expect that when subsidies are introduced, adoption will increase across the board, but especially among low-income households that might otherwise be hesitant due to cost. As more households adopt solar panels, we also expect to see the formation of larger clusters, groups of neighboring households that have adopted solar panels, indicating a stronger influence of subsidies and/or peer influence.

To better understand how each factor contributes to adoption, we'll perform a sensitivity analysis, allowing us to identify which household traits have the biggest impact on the results.

Our goal is to capture how complex and personal the decision to adopt renewable energy can be, and how the right kind of governmental support can make a meaningful difference. We hope the findings from this study can help shape smarter, more inclusive policies that accelerate the transition to clean energy, while ensuring that no community is left behind.

Why Agent-Based Modelling?

Aegent-Based Modelling (ABM) is the most appropriate modelling approach for this project, as we are interested in investigating the adoption of solar panels among households in a city. This decision is driven by the need to represent a heterogeneous population, where each agent has unique characteristics such as income level, type of residence (house or apartment), environmental consciousness, stubbornness, and susceptibility to social influence. Unlike traditional modelling techniques such as Ordinary Differential Equations (ODEs) or Markov Chains, ABM allows for the simulation of individual decision-making processes and localised interactions. In ODE-based models, populations are typically assumed to be homogeneous and well-mixed, meaning each individual is equally likely to interact with any other. This assumption ignores the complex, spatial, and network-based social structures that influence behaviour in real-world settings. Similarly, Markov Chain models rely on memoryless transitions between discrete states and are limited in their ability to capture rich, rule-based behaviour or inter-agent influence.

Moreover, ABM captures emergent macro-level behaviour that results from complex, nonlinear interactions between individual agents. Traditional models like ODEs and Markov Chains will not exhibit emergent patterns such as clustering, adoption cascades and tipping points. Additionally, a household's decision to adopt solar panels depends on the behaviour of its immediate neighbours, making localised social influence a key factor. These interactions are not only probabilistic but also vary based on agent attributes, such as stubbornness or environmental consciousness. Considering the city is divided into heterogeneous neighbourhoods, spatial structure is crucial, since the agent's location significantly affects its behaviour and influence. In conclusion, ABM allows us to model these spatial and social dynamics realistically, providing insights into how individual decisions can collectively shape city-wide adoption patterns.