

# ***BEHAVIORAL STUDIES IN ENERGY ECONOMICS: A REVIEW AND RESEARCH FRAMEWORK***

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## **Overview**

Energy markets are becoming increasingly decentral. Renewable generation is more distributed and regulators are considering decentral actions such as demand response to ensure grid stability. Furthermore, since the liberalization an increasing number of agents is active on energy markets. More utility companies hold generation capacity and more retailers cover consumer demand. Additionally, the wide landscape of different markets leads to a variety of decisions taken every day, such as market participation or dispatch decisions. Also, energy consumers are becoming more active market participants. The demand side is increasingly important for the energy market. A trend which will continue with more digitalization and the transition to a smart grid. This makes the modelling of individual agent behavior more important. It is no longer sufficient to model agents using the assumption of economically rational behavior. Especially in auction design it becomes more important to understand specific agent preferences to be able to realistically design simulation models. In this paper we provide a research framework that facilitates behavioral studies in the energy context. We base the framework on three columns: Mechanism design, lab and field experiments and data analytics. We conduct a thorough literature review of existing behavioral studies in electricity market research and classify them along the developed research framework. Furthermore, we propose the exemplary application of the developed framework to the areas of local market design, tariff design and congestion management. Therefore, the contribution of this paper is threefold:

1. Development of a framework for behavioral studies in the energy domain
2. Literature review of the defined dimensions of the research framework
3. Exemplary application of the research framework to three research areas

The results support researchers in defining their research scope and in incorporating behavioral research results into their research models and simulations. This allows for a variety of research on strategy, preferences and behavior.

## **Methods**

We first define the appropriate scope of the research framework by defining behavioral studies in energy research. From this we define the framework and according steps for behavioral research in energy markets. Along the developed framework dimensions, we then perform a systematic literature review after (Kitchenham et al. 2009) and (Webster and Watson 2010) for each individual dimension. In our review we focus on studies that combine behavioral research in energy markets with proposed solutions. This means that we exclude simple survey or preference studies unless the gained insights are combined with the development of a mechanism design. We differentiate between field experiments and lab experiments when considering behavioral studies. While we find a variety of literature for market design and analytics in the energy domain, behavioral studies are rather rare.

After having defined the research framework and conducted the according review cycles, we provide three examples to show the intended use of the framework. For local market design we define the objectives of such a market and develop mechanisms which are intended to achieve these objectives. We then describe an experimental design both in the field and in the lab to assess the performance of the mechanism and to ensure that no unintended consequences occur. Finally, we describe the use of analytics to arrive at the necessary conclusions. We then proceed and describe a similar procedure for energy tariff design and transmission congestion management. Using these example we also show how the provided framework can be included in design science cycles (Hevner et al. 2004). In doing so we also connect energy market research to information system research advancing the field of energy informatics (Watson et al. 2010).

## Results

Figure 1 provides a schematic depiction of the developed research framework. Based on the social, ecological and economical environment as well as individual preferences we focus on the areas of Experimental Design, Market Engineering and Energy Analytics to gather empirical and simulated data that we can use develop a sustainable energy system. Beyond the framework itself, our paper provides a literature overview for behavioral studies in energy economics. Finally, we provide examples for the usage of the framework and at the same provide avenues for future research.

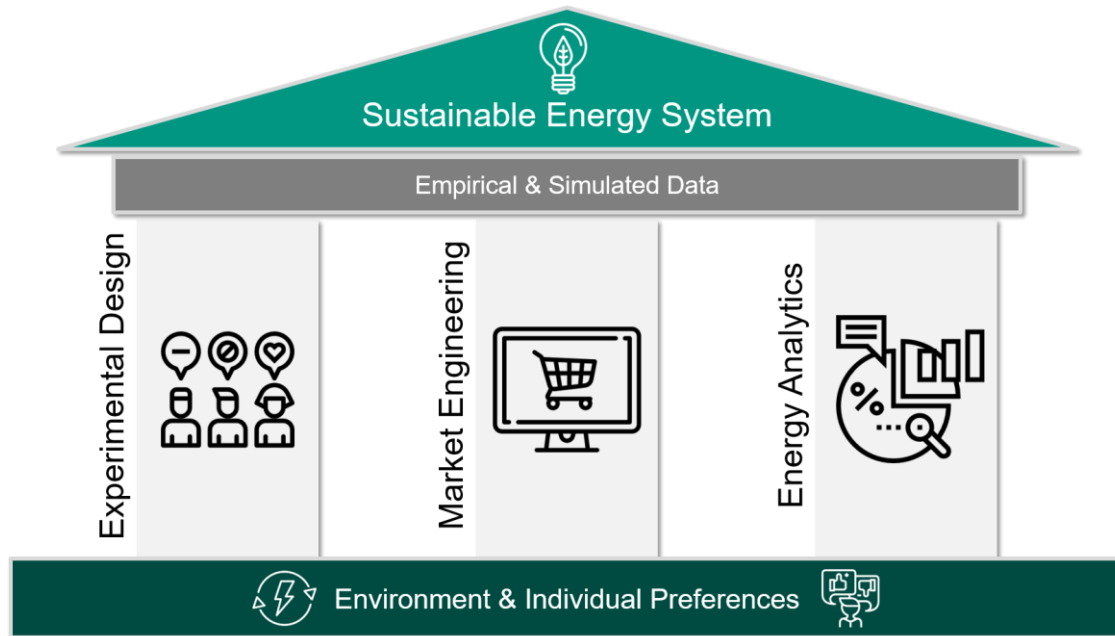


Figure 1: Schematic representation of research framework

## Conclusions

In this paper we provide a research framework as well as a literature review on behavioral studies in energy economics. With this we contribute to the research of the decentralization and the diversification of energy markets. The proposed framework can be used to ensure a holistic view on energy market research. By combining it with design science research we ensure the necessary research rigor when developing experimental designs. Finally, with this paper we emphasize the importance of actions of individual agents in modern energy markets and we draw more attention to research that considers behavioral factors in the research of energy market designs.

## References

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