

## Identifying Economic Value of Demand-side Flexibility in Energy Systems: A Systematic Review

Sophie Bredenkamp, Lena Kitzing  
DTU, Risø, Denmark

### Extended Abstract

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### Abstract Summary

As energy generation transitions from highly controllable but carbon-emitting fuels to variable renewable sources, demand-side flexibility (DSF) emerges as a useful tool for maintaining grid reliability and reducing costs. DSF allows consumers to adjust their consumption behavior in response to external signals such as changes in electricity price or renewable energy availability. Most EU member states have some form of DSF mechanism available across industrial, commercial, and residential consumers. To evaluate and compare DSF programs, it is first necessary to define value in this context. Value can be assessed from the perspective of consumers, utilities, system operators, or the overall system. Understanding the dynamics that shift value between stakeholders is critical for designing a just and equitable DSF program. However, this requires a comprehensive overview of DSF valuation metrics, which does not exist in the literature. This review surveys all journal articles from three major databases that quantify economic value metrics for DSF designs. The analysis follows a systematic literature review methodology to minimize bias and improve reproducibility. The results reveal relationships between methods and metrics, highlighting patterns in how they are combined. Statistical analysis on the prevalence of each identified metric shows that consumer cost is the most frequently cited metric, appearing in approximately 60% of studies, while there were only two citations each for transaction cost and market value of renewable energy technologies indicating substantial gaps in the literature. Levels of consensus vary depending on the type of DSF employed in the analysis. Industrial demand response (IDR), for example, has a high degree of consensus, with 40% of IDR studies that included consumer cost reporting 5-10% cost reduction for industrial consumers. This review provides a comprehensive analysis of economic DSF literature to date and supports the development of more holistic value assessment in the future.

### Presenting Author Biography

Sophie Bredenkamp is a doctoral candidate at DTU and a member of the CoDeF Marie Curie network. She earned a bachelors degree in electrical engineering and economics from Tufts University before moving on to a masters degree in advanced energy systems at the Colorado School of Mines. Before beginning her doctoral studies in Denmark, Sophie worked as a researcher at the National Lab of the Rockies, working on techno-economic and supply chain modeling of offshore wind. Sophie's PhD is focused on assessing the value of demand-side flexibility to energy systems.