

# Analysis of Natural Gas and Electricity Load Profiles for the Decarbonisation Strategy of a Commercial Area

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## ✎ EXECUTIVE SUMMARY ✎

### 1. Motivations underlying the research

Germany aims to achieve climate neutrality by 2045, with a particular emphasis on industry and commerce, which are significant energy consumers. Industry accounts for 27% of Germany's final energy consumption, whereas trade, commerce, and services account for another 15%. The electrification of industrial heating, assuming low-emission electricity sources, is a promising strategy for reducing greenhouse gas emissions. However, its feasibility depends on economic viability.

The overarching purpose of the study is to analyse the technical and economic synergies of a cross-company decarbonisation strategy within commercial areas. An energy system for an entire commercial area is modelled in order to analyse whether local energy communities can be economically advantageous in the decarbonisation of commercial areas. Since model simulation results depend on input data quality, reliable consumption profiles are crucial to evaluate the benefits of energy cooperation between companies, particularly in generation, storage, and usage. However, not every company is recording power measurements, with the result that there is no reliable energy demand data available. Thus, the focus of this study is on determining the electricity and heat demand profiles of companies in a commercial area using a combination of synthetic and real load profiles. These profiles are necessary to map the heterogeneous energy requirements of industrial and commercial companies. The challenge lies in selecting and combining synthetic profiles with different time resolutions and validities in order to realistically simulate demand profiles for electricity, gas, process heat and specific temperature levels.

Today, natural gas is typically used to generate heat. Process heat is usually required at different temperature levels. In energy models focused on decarbonising heat generation, temperature levels are crucial for selecting suitable renewable heat generation technologies. Therefore, these temperature levels must be taken into account when analysing gas demand.

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## **2. A short account of the research performed**

Electricity and natural gas load profiles for a commercial area comprising approximately 70 companies and with a size of 1.65 km<sup>2</sup> are examined. Real load profile data was collected, covering around 84% of the electricity consumption and 94% of the gas consumption within the area, using recorded power measurements. Furthermore, synthetic load profiles available in the literature were evaluated. As part of this analysis, 323 electricity load profiles from nine studies and 125 gas load profiles from five studies, including both top-down and bottom-up approaches, were analysed and compared with real data. In addition, the industry-specific temperature requirements for process heat were analysed using data from ten studies to form temperature classes for renewable heating technologies.

## **3. Main conclusions and policy implications of the work**

The comparison of synthetic profiles from the literature with the real profiles of the companies in various economic sectors within the commercial area shows that these profiles exhibit significant deviations from the measurements. Thus, as expected, the synthetic profiles are not directly usable to predict the profiles of individual companies, possibly due to heterogeneous energy requirements within the economic sectors.

The energy consumption of the entire commercial area was simulated by superposition of the synthetic individual profiles. On an aggregated level and on a weekly basis, acceptable matches are obtained. On a monthly basis, the values match up even better. Annual duration curves offer the most precise matches. Superposed load profiles can be useful for large commercial areas if many different companies are represented and the temporal resolution is sufficiently low. Validation using other commercial areas is still pending. Temperature classes developed from the study's findings allow for better matching of renewable technology to industry needs.

This research highlights the importance of synthetic profiles in bridging data gaps, despite their limited precision at higher temporal resolutions. The results highlight the need for detailed hourly to weekly load mapping, which is essential for analysing decarbonisation strategies such as the formation of energy communities. Accurate demand profiles can guide policy in energy planning and have implications for optimising decarbonisation strategies by leveraging the temporal simultaneity of energy demand and waste heat potentials between neighboring companies. Research into the impact of synthetic load profiles on energy system models remains crucial to drive decarbonisation in commercial areas. Further research is needed to refine these models and validate them against different commercial areas.