Beyond Energy Labels: Empirical Validation of EPC Classes as Predictors of Low-Temperature Heating Suitability

Nikolaus Diez*[1], Lukas Kranzl[2]

Abstract

Motivation & Challenge

Achieving the EU's heating-sector decarbonization targets requires a large share of buildings to operate at low supply temperatures, enabling high-efficiency heat pumps and low-temperature district heating [1]. Energy Performance Certificates (EPCs) are widely used to classify buildings for these transitions [2], yet it remains empirically unverified whether EPC labels meaningfully reflect the temperature requirements of heat emission systems in buildings. This lack of evidence introduces substantial uncertainty into renovation planning, technology roadmaps, and heat pump deployment strategies. A unique multi-year dataset of smart heat meters in Denmark allows, for the first time, a direct comparison between EPC classes and empirically required supply-temperature levels at high temporal resolution.

Research Questions

The research questions formulated in this context are:

- To what extent does the EPC label capture the temperature requirements relevant for assessing a building's suitability for low-temperature heating?
- Which observable building attributes account for the differences between EPC-based expectations and the temperature requirements inferred from multi-year heat-meter data?

Method

Hourly heat-meter data from approximately 34.000 meters (2018-2022) are combined with EPC information [3] to reconstruct each building's empirical heating-curve envelope and its counterfactual low-temperature (LT) operation. The dataset consists of single-family houses supplied by district heating in Aalborg Municipality, Denmark. From measured supply/return temperatures, heat flow, and volume flow, the effective mean system temperature $T_{m,old}$ is derived and filtered for physical plausibility. The upper quantile of the empirical temperature-demand relationship yields the required mean temperature $T_{m,req}(T_{out})$, which represents the minimum temperature needed to supply the observed load under cold conditions. A physics-informed approach reconstructs the building-specific heat-loss coefficient UA directly from data and uses it to compute required mean temperatures under LT operation. Supply and return temperatures are then simulated for several hydraulic design spreads ($\Delta T = 3 - 12\ K$), producing hourly LT supply-temperature series, hydraulic saturation, and building-level KPIs (e.g., $T_{sup,LT,p95}$, LT-compliance shares, winter flow intensity). These indicators are evaluated by EPC class to quantify the empirical relationship between EPC rating and actual LT suitability.

Results

Preliminary results reveal consistent thermal patterns across EPC classes. Winter LT energy intensity increases systematically from A to F (Figure 1), indicating that better-rated buildings require less heat under identical low-temperature operating assumptions. Class G deviates from this progression, which is attributable to the very small and relatively homogeneous subset of buildings in this category within the dataset. This trend is reflected in the reconstructed LT supply temperatures: median winter values

[1] Technische Universität Wien Energy Economics Group, Gußhausstraße 25/370-01, 1040 Wien, Austria, diez@eeg.tuwien.ac.at
[2] Technische Universität Wien Energy Economics Group, Gußhausstraße 25/370-01, 1040 Wien, Austria, kranzl@eeg.tuwien.ac.at

rise gradually from approximately 48 °C in class A to around 50 °C in class F (Figure 2). Although considerable within-class variation remains, this dispersion mainly reflects differences in operating behaviour and indoor temperature settings rather than limitations in the reconstruction method. Crucially, the variation does not obscure the key finding that a large share of buildings, across all EPC categories, achieves LT-compatible supply-temperature levels, often remaining below or close to 55 °C for substantial portions of the winter season. Overall, the results suggest that EPC labels capture broad thermal tendencies but tend to underestimate the proportion of buildings capable of operating at low supply temperatures.

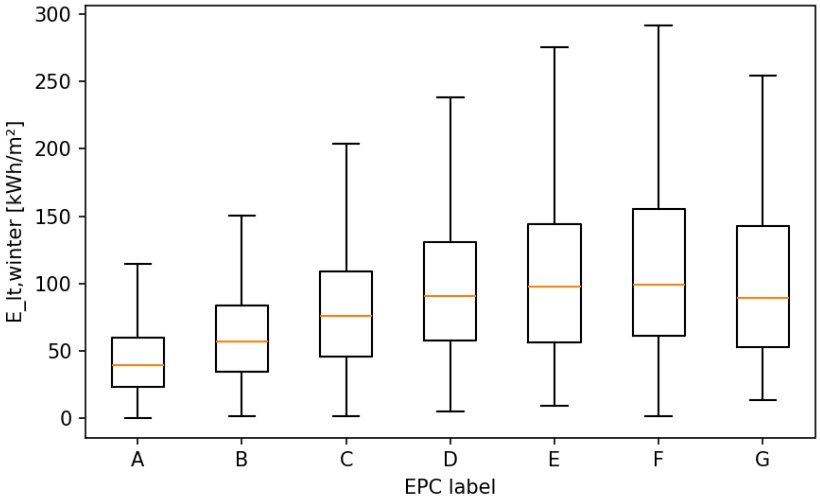

Figure 1: Winter LT energy intensity per heated area [kWh/m² (Dec-Feb)] by EPC class

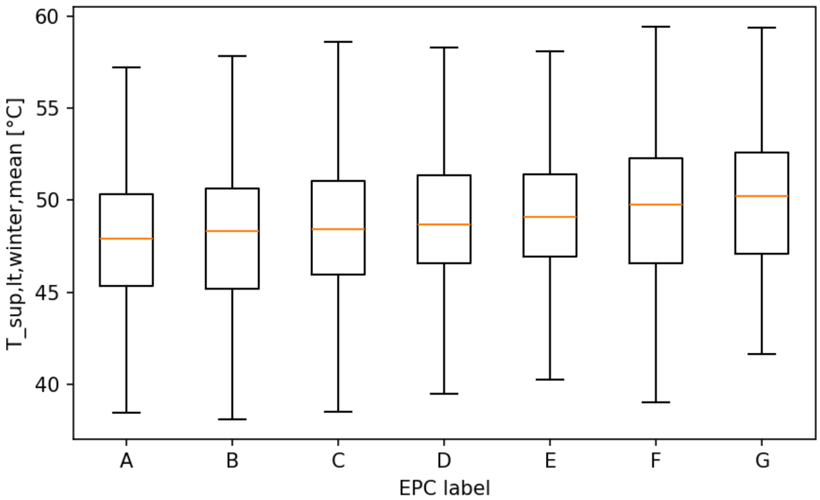

Figure 2: Mean winter (Dec-Feb) LT supply temperature [°C] by EPC class

References

[1] Maduta, C. et al., (2022), Towards a decarbonised building stock by 2050: The meaning and the role of zero emission buildings (ZEBs) in Europe, Energy Strategy Reviews, Elsevier Ltd.

[2] Kaczmarczyk, M. (2025), Energy environmental matrix for buildings energy performance certificate evaluation, Energy and Buildings, Elsevier Ltd.

[3] Schaffer, M. et al. (2024), Dataset of smart heat and water meter data with accompanying building characteristics, Data in Brief, Elsevier Ltd.