

Topic: Why do energy demand models fail to predict actual energy consumption?

Thesis focus:

The building sector is a major contributor to greenhouse gas emissions. Therefore, large amounts of capital are being invested in the transition toward energy efficient buildings, adopting multiple techniques to reduce the energy demand of homes. However, research has shown that the predicted energy demand is often not achieved after energy retrofits have been completed. This highlights a critical gap in understanding what drives energy demand and why building models have only limited predictive power for actual energy consumption.

This thesis project utilizes large datasets on energy retrofits in the UK and Canada. A central question of this thesis will be to understand how certain techniques, such as heat pumps, wall insulation, or solar panels, affect the gap between predicted and actual energy demand. Furthermore, detailed data on energy retrofit measures from residential buildings in Toronto, Canada, will be used to examine this relationship in greater depth.

In this thesis project, you will work to assemble and review energy modelling data from the City of Toronto and consumption data from utilities. You will also work with an international and interdisciplinary team to analyze the data. Researchers from U of T, EPFL, and UCL will be collaborating on this project. You will combine engineering, architectural, and economic approaches to further understand the gap between predicted and actual energy demand after energy retrofits.

Related sources:

- UK English Housing Survey: <https://www.gov.uk/government/collections/english-housing-survey>
- UK Energy Follow-up Survey: <https://www.gov.uk/government/publications/energy-follow-up-survey-efus-2017-reports>

Academic papers of interest:

- Aydin, E., Kok, N., & Brounen, D. (2017). Energy efficiency and household behavior: the rebound effect in the residential sector. *The RAND Journal of Economics*, 48(3), 749-782.
- Aydın, E., Brounen, D., & Ergün, A. (2023). The rebound effect of solar panel adoption: Evidence from Dutch households. *Energy Economics*, 120, 106645.
- Papineau, M., Rivers, N., & Yassin, K. (2025). Household benefits from energy efficiency retrofits: Implications for net zero housing policy. *Energy Economics*, 143, 108245.

- Brøgger, M., Bacher, P., Madsen, H., & Wittchen, K. B. (2018). Estimating the influence of rebound effects on the energy-saving potential in building stocks. *Energy and Buildings*, 181, 62-74.