

Housing Efficiency, Fuel Poverty, and NHS Burden:

Modelling health-equitable decarbonization pathways in England

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Extended Abstract

Introduction: Housing decarbonisation in England, through heat pump deployment and whole-house retrofit, is central to the net-zero transition. Yet fuel poverty gaps have widened despite adoption of low-carbon technologies: households in energy bands F and G face a 31.7% fuel poverty rate and an annual gap of £1,769 by 2023. The National Health Service (NHS) spends £1.4 billion annually on poor-housing-related treatment costs.

Approach: Our model integrates six interconnected modules representing housing stock dynamics, heat pump adoption via Bass diffusion, fuel cost and fuel poverty via structural energy burden, adaptive capacity with IMD-weighted health feedbacks, combined thermal-and-air-quality mortality via a validated NHS patient pathway, and NHS cost accounting. The model structure builds on a causal loop diagram developed through participatory workshops (Zhou et al., 2026). The model is parameterised across nine English regions, four EPC bands, and five IMD quintiles, calibrated on multiple datasets spanning 2010–2024.

Results: Heat pump or retrofit alone do not reduce NHS climate-related burden, and without fabric retrofit, retrofit deepens overheating for the lowest-income quintile. Retrofit without ventilation worsens health risks by increasing overheating exposure and indoor air quality hazards. Retrofit with ventilation generates the largest cross-sectoral co-benefits and avoids the overheating trap. Integrating NHS referral pathways into equitable decarbonisation supports fuel poor households and demonstrates co-benefits across sectors.

Discussion: Housing decarbonisation presents a health equity paradox: emission-oriented policies may not benefit vulnerable households or healthcare services when ventilation, fabric conditions, or fuel poverty remain unaddressed. Integrated, cross-sectoral policy design placing health equity at its center is essential for the transition to deliver co-benefits at population scale.

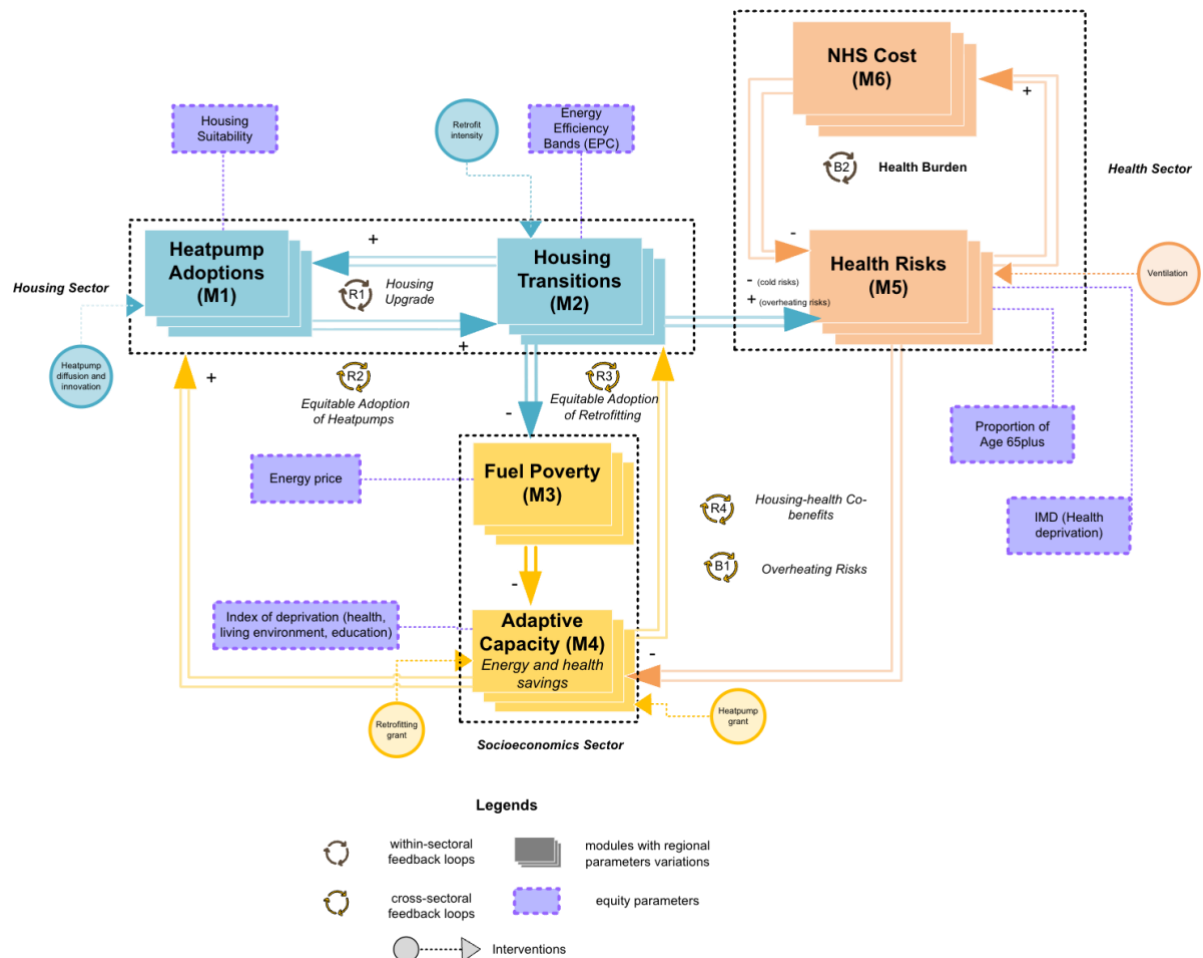


Figure- Modules overview. Note: The causal loop diagram underlying this model is described in Zhou et al. (2026).

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Reference

Zhou, K., Zimmermann, N., Davies, M., & Pluchinotta, I. (2026). *System feedback loops and pathways linking net zero policy and health equity in the UK* (SSRN Scholarly Paper No. 7442468). Social Science Research Network. <https://doi.org/10.2139/ssrn.7442468>