THE IMPACT OF CARBON EMISSIONS ON RESIDENTIAL REAL ESTATE PRICES: EVIDENCE FROM THE UK MARKET

EYLÜL ILGIN BAYSAN

ÖZYEĞİN UNIVERSITY

AUGUST, 2025

THE IMPACT OF CARBON EMISSIONS ON RESIDENTIAL REAL ESTATE PRICES: EVIDENCE FROM THE UK MARKET

by
Eylül Ilgın Baysan

Thesis
Submitted in Partial Fulfillment of the
Requirements for the Degree of

Master of Science

in
Financial Engineering

Advisor: Asst. Prof. Levent Güntay

Graduate School of Science and Engineering
Özyeğin University
İstanbul

August, 2025

THE IMPACT OF CARBON EMISSIONS ON RESIDENTIAL REAL ESTATE PRICES: EVIDENCE FROM THE UK MARKET

Approved by:

Asst. Prof. Levent Güntay, Advisor
Department of International Finance
Özyeğin University

Asst. Prof. Umut Gökçen
Department of Finance
Özyeğin University

Asst. Prof. S. Mehmet Özsoy
Department of Finance
Concordia University

Approval Date: July 28, 2025

DECLARATION OF ORIGINALITY

I hereby declare that I am the sole author of this thesis and that this is the true copy of my thesis, including the final revisions, approved by my thesis committee. All data and information have been obtained, produced, and presented in accordance with the rules of research ethics and principles of academic honesty. As required by these rules, to the best of my knowledge I have acknowledged ideas, thoughts, and any copyrighted material in accordance with the standard referencing rules. I certify that any part of this thesis has not been submitted for a degree or diploma in another educational institution.

Eylül Ilgın Baysan

ABSTRACT

This paper investigates the impact of CO_2 emissions on property prices, moving beyond the conventional notion of a single "green premium" measured solely by energy efficiency. Using a large panel dataset of property transactions and their associated Energy Performance Certificates (EPCs), I employ a fixed effects regression framework to examine how the Energy Efficiency Index (EEI) - a measure of running costs - and the Environmental Impact Index (EII) - a measure of CO_2 emissions - independently influence transaction prices. The findings reveal that the market distinguishes between these two attributes: while the EEI is valued for its cost-saving potential, the EII is priced as a proxy for unobserved property characteristics, such as amenities and high-end finishes. The valuation of these attributes exhibits substantial heterogeneity across the market. Houses, with their higher operating costs, place greater value on the EEI, whereas flats exhibit a stronger premium for the EII due to its quality signals. Tenure-based analysis provides support for the split incentive problem, and in the hyper-competitive London market, the premium for environmental impact is significantly muted, likely due to the dominance of fundamental factors such as location. These findings contribute to the literature by demonstrating that cost-saving and environmental performance are distinct value drivers, with important implications for policy-makers, investors, and real estate professionals.
Keywords: Energy Performance Certificates, Real Estate, Green Premium

ÖZET

Bu çalışma, enerji verimliliği ile ölçülen tek bir ”yeşil prim” kavramının ötesine geçerek, CO_2 salınımlarının konut fiyatları üzerindeki etkisini incelemektedir. Geniş bir konut işlem verisi ve bu işlemlere ait Enerji Performans Sertifikaları (EPCs) paneli kullanılarak, sabit etkiler (fixed effects) regresyon yöntemiyle Enerji Verimliliği Endeksi (EEI) - işletme maliyetlerinin bir göstergesi - ile Çevresel Etki Endeksi'nin (EII) - CO_2 salınımlarının bir ölçütü - konut fiyatlarını nasıl bağımsız şekilde etkilediği analiz edilmiştir. Bulgular, piyasanın bu iki özelliği birbirinden ayrı şekilde değerlendirdiğini ortaya koymaktadır: EEI, maliyet tasarrufu potansiyeli nedeniyle değer kazanırken, EII, genellikle yüksek kaliteli donanım ve diğer gözlemlenemeyen nitelikler için bir vekil gösterge olarak fiyatlanmaktadır. Bu değerlendirme eğilimleri, piyasa genelinde önemli ölçüde farklılık göstermektedir. Mülkiyet türlerine göre yapılan analizler, ”bölünmüş teşvik” (split incentive) sorununu destekler niteliktedir ve aşırı rekabetçi Londra piyasasında, çevresel etkinin sağladığı primin büyük ölçüde azaldığı görülmektedir; bu durum, lokasyon gibi temel faktörlerin baskınlığıyla açıklanabilir. Bu bulgular, maliyet tasarrufu ve çevresel performansın birbirinden farklı değer unsurları olduğunu ortaya koyarak, politika yapıcılar, yatırımcılar ve gayrimenkul profesyonelleri için önemli çıkarımlar sunmaktadır.
Anahtar Kelimeler: Enerji Performans Sertifikaları, Gayrimenkul, Yeşil Prim

ACKNOWLEDGEMENTS

I am sincerely grateful to Brydg Capital Limited for providing the final dataset that made this research possible. While the underlying sources are publicly available, compiling them into a usable form required the development of a matching algorithm. For facilitating access to the prepared dataset and supporting its use for academic research, I am especially thankful to Aysan Pamir Özel and Daniel Bendavid. Their support was not only generous but essential to the empirical analysis that follows.

I would also like to thank Asst. Prof. Levent Güntay for formally supporting this thesis within the department. The empirical direction of this thesis owes something to Assoc. Prof. Erkan Yönder, whose perspective helped frame questions more precisely.

And finally, I want to thank Asst. Prof. S. Mehmet Özsoy, a steady presence throughout this process and long before it. His influence extends well beyond these pages; he is someone I often turn to when I need clarity, no matter the question. That kind of presence is rare, and I am lucky to have it.

TABLE OF CONTENTS

DECLARATION OF ORIGINALITY iii
ABSTRACT iv
ÖZET v
ACKNOWLEDGEMENTS vi
LIST OF TABLES ix
LIST OF FIGURES x
LIST OF ACRONYMS AND ABBREVIATIONS xi
1 INTRODUCTION 1
2 LITERATURE REVIEW 7
3 DATA 10
4 METHODOLOGY AND RESULTS 17
4.1 Empirical Strategy and Baseline Results 17
4.2 Heterogeneity Analyses 21
4.2.1 Property Type 21
4.2.2 Housing Tenure 25
4.2.3 London 27
4.3 Robustness Check 30
4.3.1 Main Heat: Gas Only 30
5 CONCLUSIONS 34
REFERENCES 37
APPENDICES 39
APPENDIX A — CORRELATION MATRIX 40
APPENDIX B — REGRESSION RESULTS 41
APPENDIX C — CATEGORIZATION OF FUEL TYPES 47

APPENDIX D — EXAMPLE EPC 49

LIST OF TABLES

Table 3.1: Summary Statistics by EPC Group. 12

Table 4.1: Summary statistics for the fixed effect variables.......... 18

Table 4.2: Energy Efficiency Regressions 19

Table 4.3: Energy Efficiency and Environmental Impact Effects on Property Prices 20

Table 4.4: Interaction of Property Type with Energy Efficiency and Environmental Impact 23

Table 4.5: Interaction of Tenure with Energy Efficiency and Environmental Impact 26

Table 4.6: Interaction of London Dummy with Energy Efficiency and Environmental Impact 29

Table 4.7: Full Regression Outputs across Specifications (Gas-only Subsample).... 31

Table B.1: Energy Efficiency Regressions.......... 41

Table B.2: Energy Efficiency and Environmental Impact Effects on Property Prices . 42

Table B.3: Interaction of Property Type with Energy Efficiency and Environmental Impact 43

Table B.4: Interaction of Tenure with Energy Efficiency and Environmental Impact . 44

Table B.5: Interaction of London Dummy with Energy Efficiency and Environmental Impact 45

Table B.6: Full Regression Outputs across Specifications (Gas-only subsample)..... 46

LIST OF FIGURES

Figure 3.1: Distribution of the transaction price, EEI, and EII. 11

Figure 3.2: Distribution of EERs.. 15

Figure A.1: Correlation matrix of numeric variables.................................. 40

Figure C.1: Categorization of Main Heating Fuel Types 47

Figure C.2: Categorization of Secondary Heating Fuel Types......................... 47

Figure D.1: Example EPC 49

LIST OF ACRONYMS AND ABBREVIATIONS

EPC	Energy Performance Certificate
EEI	Energy Efficiency Index
EER	Energy Efficiency Rating
EII	Environmental Impact Index
EPBR	Energy Performance of Buildings (England and Wales) Regulations
EIR	Environmental Impact Rating

1. INTRODUCTION

Climate change is an existential threat that requires a collective, consistent, and informed effort to alleviate its impacts and mitigate the risks it poses. With the buildings and construction sector constituting 32 per cent of global energy demand and 34 per cent of total emissions [1], it is no surprise that it has become a central focus in the global effort to achieve net-zero goals.

Efforts to limit emissions in the built environment have taken many forms, one of which is the regulation of energy performance in buildings. The European Union's (EU) Energy Performance of Buildings Directive (2002/91/EC) (EPBD), followed by the revised directive (2010/31/EU), laid the principal legal basis for the member states, requiring them to establish a certification system now known as Energy Performance Certificates (EPCs) [2]. The Directive further mandates that EPCs be issued for buildings that are "constructed, sold, or rented to a new tenant" and that they be disclosed to prospective buyers/tenants, as well as "stated in advertisements in commercial media" [3]. Although the EU established the framework, member states adopted the certification programme at different times. In the case of the United Kingdom, it implemented the Energy Performance of Buildings (England and Wales) Regulations (EPBR) for the first time in 2007. Under this regulation, sellers and landlords were required to provide prospective buyers or tenants with a valid Energy Performance Certificate (EPC) at the earliest opportunity [4]. Later iterations of EPBR made it mandatory for this information to be available at the outset of the marketing process [5].

For a property to obtain an EPC, it must first be examined by an accredited energy assessor. The assessor inspects and records the relevant characteristics of the property, then inputs these observations into a software program. The procedure is entirely non-invasive, meaning that in the absence of supporting evidence, the software must make assumptions about the property's insulation quality based on its age and built type [6].

The software then produces the corresponding energy efficiency score and rating, among other metrics. The EPC ratings range from “A” (most efficient) to “G” (least efficient).

Since the widespread adoption of certification policies, there has been growing academic interest in the relationship between a property’s price and its energy efficiency. In the residential market, Fuerst et al. [7], using a dataset of 333,095 dwellings sold at least twice between 1995 and 2012, identified a positive correlation between higher EPC ratings and higher transaction price per square meter in England. However, they also documented heterogeneity in how this price premium is distributed across different property types and micro-markets: the premium was higher for terraced properties and flats compared to detached and semi-detached properties. The authors also examined price growth and EPC ratings, but they found conflicting results.

Similarly, in the Swedish housing market, Cerin et al. [8] reported that while there is a premium for energy efficiency, it is heterogeneous across property-price classes and absent in some segments of the market. Specifically, they found that energy performance commands a premium in the lower-priced segment but not among the most expensive properties. They also observed that the premium depends on the construction age of the property, with older properties more likely to benefit from a price premium. The common thread in both findings is that older and less expensive properties tend to have lower energy efficiency on average, suggesting that the premium for energy efficiency increases in situations where the baseline condition is worse.

The literature generally agrees that energy efficiency has a somewhat positive impact on house prices. It is therefore important to understand whether this premium arises from energy efficiency itself or other omitted attributes, and whether the mandatory information disclosure policies, such as the UK’s EPBR Amendment, contribute to the rate of this capitalisation. While the first question seeks to uncover market preferences regarding energy efficiency, the second aims to assess whether current policy trends in the developed world, which require EPCs to be disclosed at the outset of the marketing process, are effective in supporting the goal of decarbonizing the built environment.

To this end, Jensen et al. [9] examined the capitalisation of energy efficiency in the Danish housing market by comparing the price premium before and after 2010. Denmark, one of the earliest adopters of the EPC scheme, implemented the 2010 EPBD Amendment with notable speed, putting it into effect on 1 July 2010. This rapid adoption made Denmark one of the first countries to enforce the requirement that energy performance ratings be included in commercial advertisements. As such, 2010 represents a key turning point, serving as a policy shock that significantly increased the salience of EPC information for prospective buyers. Despite Denmark's early adoption of the EPC framework, Jensen et al. [9] reported that no significant price response to energy efficiency was observed before 2007. While the authors found that the impact was more pronounced after the disclosure policy was implemented, it is important to note that their study used a relatively small sample (117,483 properties in total), focused only on single-family houses, and more importantly, missed key property characteristics such as the number of rooms, thereby increasing the risk of omitted variable bias commonly found in models of this nature.

In their paper, Aydin et al. [10] examined the capitalisation of energy performance in the Dutch housing market by employing an instrumental variable (IV) approach to address limitations in earlier research, such as the aforementioned omitted variable bias. They found evidence of such capitalisation but concluded that the mandatory information disclosure policy did not significantly influence the extent of it.

As summarised above, since the late 2000s, research in this domain has used buildings' energy efficiency ratings, particularly in EU countries, as the primary metric measuring energy efficiency and, by extension, the so-called "green premium". However, this approach can be somewhat misleading, especially in the UK. The EPC rating is primarily designed to indicate how costly a dwelling is to operate for the homeowner. As such, the headline EPC rating functions more as a cost-based index than as a direct measure of environmental impact. The rating takes into account the type of main fuel used and its price, but not the specific CO_2 emissions associated with that fuel type [11].

In the context of an EPC, the Energy Efficiency Index (EEI) is the underlying metric from which the Energy Efficiency Rating (EER), the headline rating displayed on the certificate, is derived, while the Environmental Impact Index (EII) measures the property's CO_2 emissions. It might be argued that the less efficient a home is, the more CO_2 it will emit. This is generally true, and a high correlation is observed between EEI and EII. However, this relationship holds primarily when the emissions associated with a particular fuel type move in conjunction with its price, which is often not the case. For example, a higher-cost fuel type would worsen the EEI without necessarily increasing CO_2 emissions. Similarly, a secular relative price increase in a particular fuel –such as natural gas– could negatively affect the EEI, even though the amount of CO_2 emitted per cubic metre of gas remains unchanged.[1]

Due to the cost-saving implications of the EEI, it is difficult to determine whether its impact on property prices reflects increased environmental awareness or simply a rational decision to reduce operating costs, as price changes should matter for the latter but not the former.

I therefore argue that it is more appropriate to measure the impact of the EII –or direct CO_2 emissions– on property prices rather than the EEI. To the best of my knowledge, no existing study has investigated whether the CO_2 emissions, separately from operational cost concerns, are capitalised into property prices, thereby positioning this paper as the first of its kind within this strand of literature.

[1] In fact, total carbon emissions might even decrease if demand exhibits any price elasticity and consumers reduce their fuel consumption in response to higher prices.

One of the more recent and geographically relevant studies focused on the impact of the 2011 EPBR amendment in the UK, which required EPC information to be prominently displayed at the outset of the marketing process. Ghosh et al. [12] examined the willingness-to-pay (WTP) of buyers before and after the amendment and documented an increase in WTP following the policy change. In this context, they define WTP as the additional premium buyers are willing to pay for more energy-efficient properties after receiving clearer and more accessible information about energy performance. This effect is quantified using difference-in-difference (DD) estimates, capturing the extent to which the salience of EPC information influences buyer behaviour.

According to their findings, WTP exhibits heterogeneity, with buyers in London showing a greater increase than the national average. To identify the mechanism behind this increase, they considered the consumption, information, and market valuation channels. They found no rise in WTP in regions where households face higher energy bills or where average temperatures are lower, hence ruling out the consumption channel.

For the information channel, they argue that since EPCs become more visible from the very start, the value placed on "hard-to-observe characteristics" in the full EPC report, such as insulation and CO_2 emissions, should have increased. However, they observed no significant change in how these characteristics are priced, consequently ruling out the information channel as well. Regarding the market valuation channel, they documented a considerable increase in WTP in areas with higher price-to-income ratios and higher rates of housing tenure. They concluded that the increased salience of EPCs leads buyers to perceive the rating itself as a determinant of price, and thus as a contributor to potential investment returns. This, in turn, makes buyers more willing to pay for higher-rated properties.

As this paper investigates the impact of CO_2 emissions on property prices, the so-called hard-to-observe characteristics, CO_2 emissions being one of them, are of particular relevance. One could argue that the majority of hard-to-observe characteristics are inherently difficult to price for the average buyer on the grounds that the effect of features such as “glazing type” or “heat loss corridor” on insulation and overall energy efficiency is not easily understood. It is also plausible that buyers already incorporate these characteristics into their valuation of the energy efficiency score, albeit not explicitly. CO_2 emissions, or its proxies such as the Environmental Impact Rating (EIR) in the EPC certificate, are far more intuitive. For most people, they offer a direct measure of the environmental harm associated with a prospective property. Since Ghosh et al. [12] focused primarily on the efficacy of the EBPR amendment itself, they did not investigate whether CO_2 emissions are already capitalised into property prices. This is the central question this paper aims to address.

2. LITERATURE REVIEW

This literature review lays the theoretical and methodological groundwork for the principal empirical instrument used in this paper: the hedonic pricing model. I begin by outlining its theoretical background, then discuss why the real estate market is particularly well-suited to this approach, and finally address key methodological considerations relevant to its application.

The conceptual origins of hedonic pricing can be traced back to Lancaster [13], who proposed that consumers derive utility not from goods themselves, but from the individual attributes that constitute them. Building on this framework, Rosen [14] developed a formal model of market equilibrium for differentiated products, offering an empirical structure for estimating how prices are determined in markets where goods vary in their attributes. In Rosen's [14] formulation, the hedonic price function takes the general form:

$$P(z) = p(z_1, \ldots, z_n) \tag{2.1}$$

where $P(z)$ denotes the observed price of a good and each z_i represent one of its measurable characteristics. In practice, this function is typically estimated by regressing observed product prices on their measurable attributes.

The real estate market is particularly well-suited for the application of hedonic pricing models. Residential properties are inherently heterogeneous, and their prices reflect a composite of structural features (e.g., size, number of rooms), locational attributes (e.g., proximity to amenities, views, transport links), and neighbourhood qualities (e.g., school quality, crime rates). Since no two properties are exactly alike, the ability to isolate the marginal contribution of each characteristic is especially valuable for understanding price formation in housing markets. Indeed, scholars have applied hedonic pricing models to evaluate a wide range of property attributes, from the impact of rail transport [15] and educational outcomes [16] to the effects of listing a property as vacant versus rented at the time of sale [17].

One of the earliest and most influential applications of this approach was the work of Ridker and Henning [18], which examined the impact of air pollution on residential property values. Using a comprehensive set of housing and neighborhood characteristics, including submarket variables such as racial composition, the authors demonstrated that higher levels of air pollution, measured by sulfation rates, had a statistically significant and negative effect on property values. This study was pioneering in its quantification of environmental externalities within the housing market and laid the groundwork for a substantial body of research. Since then, a rich body of literature has applied hedonic models to study the capitalisation of various environmental risks, including flood exposure [19], air quality and noise pollution [20], and proximity to hazardous sites [21] into property prices.

However, the application of hedonic pricing models is not without methodological challenges. One prominent issue is omitted variable bias. As Linneman [22] noted, unobserved or unmeasured neighborhood attributes can be critical determinants of property values. When such omitted variables are correlated with included regressors, they can bias coefficient estimates and undermine the validity of statistical inference.

Linneman [22] also contributed to the refinement of hedonic model implementation by examining the role of functional form. While Rosen's [14] original framework did not prescribe a specific functional form for the hedonic price function, Linneman [22] argued that the choice of functional form should be data-driven, warning that misspecification can be a "potentially serious source of bias." Ultimately, the optimal functional form may vary depending on context and should be determined empirically.

Multicollinearity is another important concern in real estate applications of hedonic pricing models. Many housing attributes are inherently correlated; for example, energy efficiency measures such as the EEI and the EII are both related to a property's insulation and building fabric, and are jointly influenced by energy consumption patterns. Similarly, size and number of rooms are almost always positively correlated, while older properties often negatively correlate with the presence of modern amenities. These high correlations among regressors can make it difficult to precisely estimate the individual effect of each attribute, thereby complicating interpretation and reducing the reliability of coefficient estimates.

Overall, the hedonic pricing model offers a rigorous and adaptable approach for disentangling the value of individual housing attributes in complex and heterogeneous property markets. Its broad applicability and theoretical grounding make it particularly well-suited for real estate analysis. However, its successful implementation depends on addressing several methodological challenges, including functional form specification, omitted variable bias, and multicollinearity, which, if unaddressed, can undermine the credibility and interpretability of the findings.

3. DATA

The primary dataset used in this study was obtained from Brydg Capital Limited, a real estate-backed lending company based in the United Kingdom. They matched and merged two publicly available datasets: Price Paid Data from Her Majesty's Land Registry (HMRC) and Energy Performance of Buildings Data: England and Wales from the Department for Levelling Up, Housing & Communities (DLUHC). While the original data sources are publicly accessible, Brydg Capital matched the addresses across both datasets for use in loan underwriting. I obtained the merged dataset from them for the purpose of this research.

The HMRC dataset includes the near-universe of all residential property transactions in the United Kingdom since 1995. It contains information such as the transaction date, transaction price, address, and some basic property characteristics. Additional property characteristics, as well as the EPC rating, EIR rating, and CO_2 emissions, are sourced from the EPC dataset provided by the DLUHC, which covers the period from 2008 onwards.

I exclude transactions where the EPC lodgement date is later than the transaction date, on the grounds that this information would not have been available to the buyer at the time of purchase and thus could not have influenced the price. Similarly, I exclude transactions where there is a gap of more than five years between the lodgement date and the transaction date, as the information contained in the EPC is likely to be outdated in such cases.

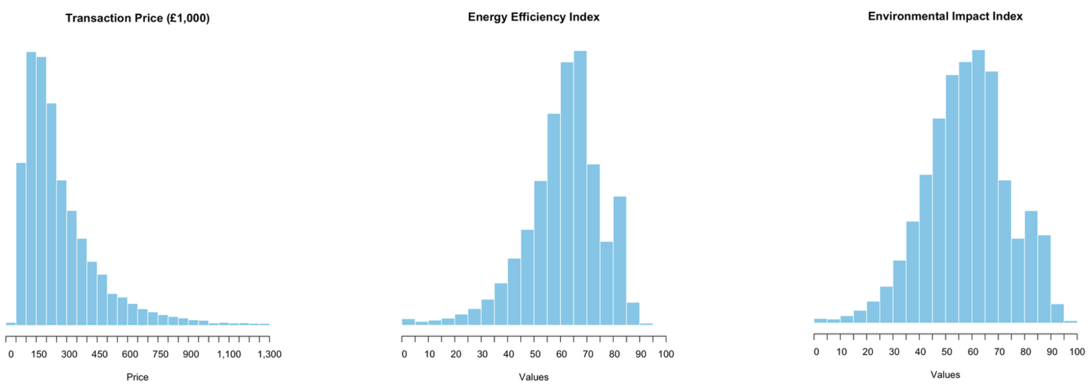
I further exclude social housing, as the pricing dynamics of these types of properties are categorically different than those of private properties. This exclusion has minimal impact on the sample size, as there were only 34,065 observations in this category.

For transactions with more than one EPC available at the time of sale, I retain the one matched with the most recent EPC.

The final dataset includes 5,640,747 transactions spanning the period from 2008 to 2023. The total number of unique properties transacted is 4,727,843, with 817,655 properties having transacted more than once. To eliminate outliers, defined by the first and 99th percentiles, I winsorize all variables of interest, except for the EEI and EII. For these two indices, I cap the values at 100 and floor them at 1. This is because both indices are intended to fall within a 1-100 scale; however, both can exceed 100 if the property is equipped with a sufficient renewable energy generator, effectively making it a net exporter of energy [23].

In Figure 3.1, I present the distribution of transaction prices, the EEI, and the EII within this sample.

Figure 3.1: *Distribution of the transaction price, EEI, and EII.*



Note: The distributions are based on the raw sample before winsorization.

Table 3.1 presents the summary statistics for the main variables of interest, along with the control variables.

Table 3.1: *Summary Statistics by EPC Group.*

Variable	A, B, C	D, E, F, G
Transaction Price (£1,000)	3.19	2.91
	(2.04)	(1.84)
Log (Transaction Price per Square Meter)	1.01	0.90
	(0.53)	(0.58)
Energy Efficiency Index (EEI)	76.30	55.03
	(5.92)	(11.91)
Log (EEI)	4.33	3.96
	(0.08)	(0.39)
Environmental Impact Index (EII)	75.72	50.78
	(8.33)	(11.80)
Log (EII)	4.32	3.89
	(0.11)	(0.34)
CO_2/Size	27.54	56.76
	(10.46)	(18.40)
Log (CO_2/Size)	3.23	3.99
	(0.42)	(0.29)
Size (m^2)	91.71	98.21
	(42.99)	(43.10)
Log (Size)	4.43	4.51
	(0.41)	(0.38)
Number of Rooms	4.45	4.86
	(1.64)	(1.55)
Energy Rating (fraction)		
A	0.004	
B	0.301	
C	0.695	
D		0.636
E		0.273
F		0.070
G		0.021
Property Type (fraction)		
House	0.684	0.788
Maisonette	0.020	0.015
Flat	0.251	0.077

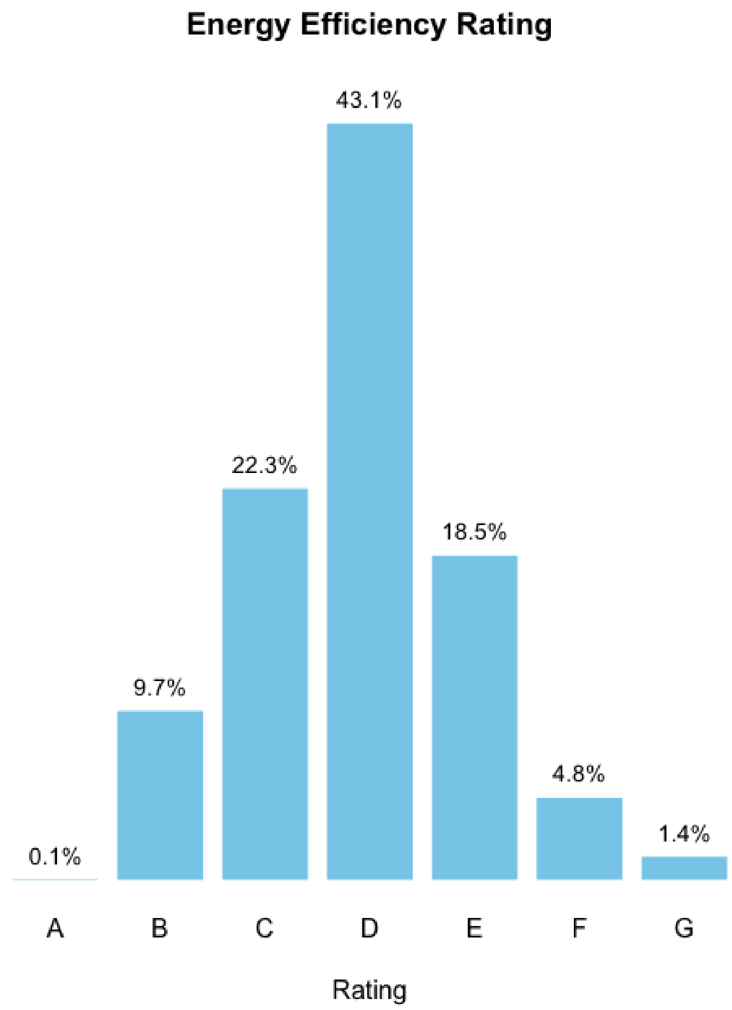
Variable	**A, B, C**	**D, E, F, G**
Bungalow	0.044	0.119
Park Home	0.000	0.000
Built Form (fraction)		
Detached	0.272	0.262
Semi-Detached	0.275	0.350
End-Terrace	0.129	0.116
Mid-Terrace	0.260	0.257
Enclosed Mid-Terrace	0.011	0.004
Enclosed End-Terrace	0.014	0.007
Unknown	0.039	0.005
Main Fuel (fraction)		
Gas	0.870	0.859
Others	0.126	0.136
No Heating	0.004	0.005
Tenure (fraction)		
Owner-Occupied	0.636	0.893
Rental (Private)	0.074	0.081
Unknown	0.290	0.026
Construction Age (fraction)		
Pre-1900	0.025	0.146
1900–1929	0.044	0.204
1930–1966	0.154	0.371
1967–1995	0.227	0.238
1996–2023	0.241	0.031
Unknown	0.309	0.010
Obs.	1,814,435	3,826,312
Obs. (Number of Rooms)	1,206,821	3,803,458

Note: Descriptive statistics are reported separately for properties based on their Energy Efficiency Ratings (EERs). Descriptive statistics are calculated after the winsorization procedure.

Based on this preliminary analysis, more energy-efficient properties are, on average, sold at higher prices per square meter, emit less carbon, and are slightly smaller in size. This is expected, as they contain a significantly larger proportion of flats compared to the less efficient sample. More efficient properties also tend to be newer builds, with 46.8% constructed after 1967, compared to just 26.9% among the less efficient properties.

In addition to the distribution of EEI, I also present the distribution of EER in Figure 3.2.

Figure 3.2: *Distribution of EERs.*



Note: The ratings are derived from the EEI based on the following bands: A (92+), B (81-91), C (69-80), D (55-68), E (39-54), F (21-38), and G (1-20).

Before moving on to the model specification, it is important to clarify the distinction between EEI and EII, both of which are reported in EPCs. Both EEI and EII are "asset ratings" in the sense that they are based on the physical characteristics of the property as well as local climate conditions, rather than household behaviour. The EEI is a function of the energy costs required to operate the property, adjusted for floor area. Its formulation is as follows:

$$\text{ECF} = \frac{\text{deflator} \times \text{total cost}}{\text{TFA} + 45}$$

$$\text{EEI} = \begin{cases} 117 - 121 \times \log(\text{ECF}) & \text{if ECF} \geq 3.5 \\ 100 - 13.95 \times \text{ECF} & \text{if ECF} < 3.5 \end{cases} \tag{3.1}$$

The EII, on the other hand, is a function of the property's CO_2 emissions and is formulated as follows:

$$\text{CF} = \frac{\text{CO}_2 \text{ emissions}}{\text{TFA} + 45}$$

$$\text{EII} = \begin{cases} 200 - 95 \times \log(\text{CF}) & \text{if CF} \geq 28.3 \\ 100 - 1.34 \times \text{CF} & \text{if CF} < 28.3 \end{cases} \tag{3.2}$$

Both indices are designed to be independent of the property's size. While they naturally depend on the type of fuel used and the quality of the building fabric by way of the amount of energy required to operate the property, they are intended to capture the different outcomes resulting from these attributes.

As expected, these variables exhibit a high degree of correlation. Specifically, the raw indices are correlated at 0.9431, while their logarithmic forms display a slightly lower yet still strong correlation of 0.8322. The correlation matrix for all the numeric variables is provided in Appendix A.

4. METHODOLOGY AND RESULTS

4.1 Empirical Strategy and Baseline Results

As in the broader literature in this field, I employ Rosen's [14] hedonic pricing model to decompose the price of a property into its observable characteristics. In principle, and in the absence of omitted variables, each coefficient should reflect the exact premium (or discount) that the market places on a given characteristic.

I begin by using the categorical variable, EER, to investigate the relationship between property prices and energy efficiency. This approach is justified by the fact that these labels are the first element a prospective buyer or tenant sees on the EPC and are far more intuitive for comparison purposes.

I then specify the initial hedonic model as follows:

$$\log(\text{Price per sqm}_{it}) = \beta_0 + \sum_{k \neq D}^{K} \beta_k \, \text{Rating}_k + \beta_1 X_{it} + \theta_n + t_i + \varepsilon_{it} \tag{4.1}$$

The dependent variable is the logarithm of the transaction price per square meter of property i at time t, and Rating_k denotes the EER of the property, with Rating D used as the baseline reference category. I control for a set of property characteristics with X_{it}. All models also control for location and time through fixed effects, denoted by θ_n and t_i, respectively.

For the remainder of this paper, I control for location using the local authority variable from the EPC dataset, which contains the official Office for National Statistics (ONS) codes for the corresponding geographical areas. The sample includes 346 local authority codes. Fixed effects are implemented at the local authority level rather than the constituency level, on the grounds that local authorities serve as the administrative divisions of local government and are responsible for delivering public services, thus having a direct impact on property prices.

Time controls are based on calendar quarters derived from the transaction dates, covering 61 periods from 2008Q4 to 2023Q4. Summary statistics for these variables are presented in Table 4.1.

Table 4.1: *Summary statistics for the fixed effect variables.*

Fixed Effects	Mean	Std	Min	Max
Number of Properties by LA	13,674.39	9,746.37	67	77,677
Number of Transactions in Calendar Quarters	92,471.26	26,941.90	7,038	134,942

Note: There are 346 local authorities and 61 calendar quarters available in the sample. Local authorities are represented as official ONS codes.

I begin by estimating Equation 4.1 using ordinary least squares (OLS). I then replace the categorical EER variable with continuous measures of energy efficiency, namely EEI and its logarithmic form. The rationale for this approach is as follows: since categorical labels group properties with varying energy efficiency levels into broad bands, they lack granularity and limit the precision of the analysis. To account for the impact of incremental changes in energy efficiency, it is more appropriate to use a continuous measure that captures within-category variation and allows for the estimation of the marginal effect of improvements in energy efficiency. Additionally, I apply a logarithmic transformation to capture potential non-linear effects, which also enables interpretation of the results in terms of elasticity.

Accordingly, I estimate the following equations:

$$\log(\text{Price per sqm}_{it}) = \beta_0 + \beta_1\,\text{EEI}_{it} + \beta_2\,X_{it} + \theta_n + t_i + \varepsilon_{it} \tag{4.2}$$

$$\log(\text{Price per sqm}_{it}) = \beta_0 + \beta_1 \log(\text{EEI}_{it}) + \beta_2 X_{it} + \theta_n + t_i + \varepsilon_{it} \tag{4.3}$$

I present the OLS results in Table 4.2, while the full specification – including control variables – is provided in Appendix B. The results from Model (1) indicate a monotonic relationship between energy efficiency and property prices, with the coefficient gradually declining from 0.025 for Rating A to -0.140 for Rating F. Models (2) and (3) also support a positive association between energy efficiency and transaction price, regardless of how energy efficiency is measured, thereby reinforcing the credibility of the premium effect.

Table 4.2: *Energy Efficiency Regressions*

Dependent Variable: logpricepersqm	**(1)**	**(2)**	**(3)**
Rating: A	0.025***		
	(0.008)		
Rating: B	0.014**		
	(0.007)		
Rating: C	0.011***		
	(0.002)		
Rating: E	-0.025***		
	(0.002)		
Rating: F	-0.053***		
	(0.004)		
Rating: G	-0.140***		
	(0.006)		
EEI		0.002***	
		(0.0001)	
Log (EEI)			0.066***
			(0.003)
Location & Time Fixed Effects	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes
Observations	5,010,279	5,010,279	5,010,279
Adjusted R^2	0.742	0.742	0.742

Note: *** denotes significance at 0.01, ** at 0.05, and * at 0.1. The dependent variable in all regressions is the logarithm of transaction price per square meter. Property characteristics included are: logarithm of floor area, number of rooms, property type, tenure, built form, dummy denoting whether the property is a new build, and main fuel type. Standard errors are clustered by local authority and transaction quarter.

Having discussed the distinction between EEI and EII, and presented robust evidence of a price premium for more energy-efficient properties, this paper now investigates whether, holding energy efficiency constant, the environmental impact of a property, e.g., CO_2 emissions, influences transaction prices. The sample includes two variables suitable for this analysis: CO_2 emissions per floor area and the EII. I first incorporate CO_2/Size and EII to Equation 4.2, followed by their logarithmic forms, log(CO_2/Size) and log(EII), into Equation 4.3. The results are presented in Table 4.3.

Table 4.3: *Energy Efficiency and Environmental Impact Effects on Property Prices*

Dependent Variable: logpricepersqm	**(1)**	**(2)**	**(3)**	**(4)**
EEI	0.0003	-0.001***		
	(0.0002)	(0.0003)		
EII	0.002***			
	(0.0002)			
CO_2/Size		-0.002***		
		(0.0002)		
Log (EEI)			0.032***	0.033***
			(0.004)	(0.003)
Log (EII)			0.051***	
			(0.005)	
Log (CO_2/Size)				-0.064***
				(0.006)
Location & Time Fixed Effects	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes
Observations	5,010,279	5,010,279	5,010,279	5,010,279
Adjusted R^2	0.743	0.743	0.743	0.743

Note: *** denotes significance at 0.01, ** at 0.05, and * at 0.1.

When modelled separately, both EEI and EII are significantly associated with transaction price. However, when both indices are included in the same specification, Model (1), the coefficient on EEI becomes statistically insignificant, while EII remains significant and positive. Taken together with the strong positive correlation between the two indices, these results suggest the presence of collinearity and conceptual overlap.

Similarly, in Model (2), when EEI is included alongside the raw CO_2/Size, the coefficient for EEI turns negative, although it remains statistically significant. This result is likely driven by differences in units and scale. EEI is adjusted by total floor area plus 45 and then scaled to 1-100 range, whereas CO_2 emissions are adjusted only by the total floor area and remain in raw units. This mismatch in scale and distribution introduces statistical noise and makes interpretation very counterintuitive. These challenges highlight the advantage of using composite indices like EEI and EII, which are specifically designed to normalize values across properties and facilitate comparison. While raw measures can offer granularity, indices provide greater consistency and interpretability within a regression framework.

In Models (3) and (4), where I use logarithmic transformations of all variables of interest, the results appear more stable. Log (EEI) is positively associated with transaction price, while the logarithmic forms of the CO_2-related variables indicates that an adverse environmental impact is negatively associated with property prices. Specifically, a 1% increase in EII is associated with a 0.051% increase in property price, on average.

For the remainder of the paper, I use the logarithmic forms of both EEI and EII to ensure statistical robustness and ease of interpretation, and I explore whether these results exhibit heterogeneity across different property types, tenures, and buyer preferences.

4.2 Heterogeneity Analyses

4.2.1 Property Type

To identify potential heterogeneity in the valuation of energy efficiency and environmental impact, I begin by examining the differential effects between houses and flats. This is done by interacting log (EEI) and log (EII) with a house dummy. Given the structural characteristics, size differences, and generally higher operating costs associated with houses compared to flats, I expect the premium to differ across these property types. I formalize the regression equation as follows:

$$\begin{aligned}\log(\text{Price per sqm}_{it}) = \beta_0 &+ \beta_1 \log(\text{EEI}_{it}) + \beta_2 \log(\text{EII}_{it}) \\ &+ \beta_3 \left[\log(\text{EEI}_{it}) \times \text{House}_i\right] + \beta_4 \left[\log(\text{EII}_{it}) \times \text{House}_i\right] \\ &+ \beta_5 \text{House}_i + \beta_6 X_{it} + \theta_n + t_i + \varepsilon_{it}\end{aligned} \tag{4.4}$$

Results are presented in Table 4.4.

Table 4.4: *Interaction of Property Type with Energy Efficiency and Environmental Impact*

Dependent Variable:	**logpricepsqm**
Log (EEI)	-0.033***
	(0.011)
Log (EII)	0.129***
	(0.013)
Type: House	0.206***
	(0.045)
Log (EEI) * Type: House	0.074***
	(0.011)
Log (EII) * Type: House	-0.087***
	(0.013)
Location & Time Fixed Effects	Yes
Control Variables	Yes
Observations	4,397,102
Adjusted R^2	0.748

Note: *** denotes significance at 0.01, ** at 0.05, and * at 0.1.

As expected, both energy efficiency and environmental impact are valued significantly differently depending on property type. More specifically, a 1% increase in EEI is associated with a 0.041% premium for houses, whereas it corresponds to a 0.033% discount for flats. In contrast, a 1% increase in the EEI results in a 0.042% premium for houses and a 0.129% premium in flats. It is worth reiterating at this point that houses make up approximately 75.5% of the full sample, while flats account for 13.3%.

It is reasonable that EEI is primarily valued in houses, given the larger size and higher running costs. The more puzzling question is why EEI appears to be negatively associated with flat prices. While the current setup does not allow for direct testing of this hypothesis, one possible explanation is that the actual monetary savings from energy efficiency in flats may be relatively trivial. Since flats already incur lower energy costs compared to houses, a prospective buyer or tenant may be indifferent to a £100 annual reduction in utility bills, particularly when weighed against more substantial expenses such as service charges and property taxes, which may have a greater influence on purchasing decisions.

Turning to environmental impact, it appears to be valued more highly in flats than in houses. In this case, it is likely that the environmental impact measure also captures certain unobserved characteristics specific to flats. While the EII is a measure of CO_2 emissions, it is also strongly correlated with properties being newly built and well-constructed. It is therefore reasonable to assume that such flats may also feature modern amenities. Although I control for new builds and account for building fabric quality through insulation and its effects on energy usage and environmental impact, I am unable to control for the presence of amenities. As such, it is likely that buyers are not valuing the low environmental impact per se, but rather the modern features that tend to accompany it. In contrast, given the heterogeneity in the housing stock, the EII itself may not convey as strong or consistent a signal of modern amenities in houses as it does in flats.

Moreover, houses and flats tend to be marketed to different types of buyers. If we simplify this distinction and assume that houses are primarily targeted toward families, while flats appeal to young professionals, the EII may function as a social signal for eco-friendliness, an attribute that young professionals are arguably more likely to value. In contrast, families may understandably prioritise factors such as school districts, a sense of community, and access to outdoor space over environmental considerations.

4.2.2 Housing Tenure

I then turn to the role of tenure. Having excluded social housing, the sample consists of owner-occupied and private rental properties. The fundamental distinction between these two tenure types lies in the split incentive problem, wherein the landlord is responsible for investing in the property, while the tenant receives the benefits, such as lower energy bills and improved comfort [24]. While it could be argued that landlords may recover these costs through higher rents, in the absence of perfect capitalisation, paying a premium for energy-efficient or environmentally friendly properties may not be a rational choice for a prospective landlord.

To test this, I define the regression equation as follows:

$$\begin{aligned}\log(\text{Price per sqm}_{it}) = \beta_0 + \beta_1 \log(\text{EEI}_{it}) + \beta_2 \log(\text{EII}_{it}) \\ + \beta_3 \left[\log(\text{EEI}_{it}) \times \text{Owner}_i\right] + \beta_4 \left[\log(\text{EII}_{it}) \times \text{Owner}_i\right] \\ + \beta_5 \text{Owner}_i + \beta_6 X_{it} + \theta_n + t_i + \varepsilon_{it}\end{aligned} \tag{4.5}$$

Table 4.5 provides supporting evidence for the split incentive problem: the coefficient for Log (EEI) is statistically insignificant, whereas the interaction term with the owner-occupied dummy is both significant and positive.

Table 4.5: *Interaction of Tenure with Energy Efficiency and Environmental Impact*

Dependent Variable:	**logpricepersqm**
Log (EEI)	0.002
	(0.008)
Log (EII)	0.115***
	(0.011)
Tenure: Owner-occupied	0.198***
	(0.037)
Log (EEI) * Tenure: Owner-occupied	0.032***
	(0.007)
Log (EII) * Tenure: Owner-occupied	-0.069***
	(0.011)
Location & Time Fixed Effects	Yes
Control Variables	Yes
Observations	4,908,312
Adjusted R^2	0.742

Note: *** denotes significance at 0.01, ** at 0.05, and * at 0.1.

The more intriguing finding lies in the interaction term involving log (EII) and the owner-occupied dummy. Why would a rental property with lower CO_2 emissions command a higher premium than an owner-occupied one? It is likely that the same dynamics discussed in the previous section are at play. For an investor purchasing a property as an asset, the EEI may signal cost savings for the tenant, while the EII could be interpreted as a proxy for lower risk and asset quality. In the presence of collinearity between these two variables, it is plausible that the perceived asset quality is being captured by the EII rather than by the EEI.

It is also important to note that the tenure information is sourced from the EPC dataset and therefore reflects the occupancy status at the time of the EPC assessment, not at the time of the property transaction. As a result, if there is a change in occupancy between the assessment and the sale, or if a buyer intends to change the tenure after purchase, the model is unable to account for this.

According to the 2023-24 English Housing Survey [25], 64% of the housing stock is owner-occupied, while 19% is privately rented. In my sample, however, there is a notable disparity in ownership structure: 81% of properties are owner-occupied, 8% are private rentals, and 11% have undetermined tenure status. Even after accounting for the exclusion of social housing, the representation of private rental properties in the sample appears rather low, suggesting that the analysis may not fully reflect the broader market dynamics.

4.2.3 London

I then examine the London effect. Environmental concerns are highly personal, and the premium individuals are willing to pay for such attributes is inherently subjective. As both an economic powerhouse and a global city, London frequently diverges from the rest of the UK in key political and social trends, as evidenced by the Brexit referendum, the 2011 London riots, and its more liberal stance on immigration and multiculturalism. The London property market also differs markedly from the rest of the UK, characterised by significantly higher prices, unique market drivers, and a different demographic of buyers and renters. To assess how London buyers respond to energy efficiency and environmental impact, I define the following specification:

$$
\begin{aligned}
\log(\text{Price per sqm}_{it}) = \beta_0 &+ \beta_1 \log(\text{EEI}_{it}) + \beta_2 \log(\text{EII}_{it}) \\
&+ \beta_3 \left[\log(\text{EEI}_{it}) \times \text{London}_i\right] + \beta_4 \left[\log(\text{EII}_{it}) \times \text{London}_i\right] \\
&+ \beta_5 X_{it} + \theta_n + t_i + \varepsilon_{it} \qquad (4.6)
\end{aligned}
$$

where there is no London dummy included separately in the regression, as the London effect is already controlled by the local authority fixed effects.

Table 4.6 shows that while buyers in London do not pay an additional premium for energy efficiency beyond the existing national premium, the premium associated with environmental impact appears to be significantly lower in London compared to the rest of the UK. This finding is reasonable, as the cost-saving aspect of the EEI remains relevant and valuable to buyers in London, despite the overall higher property prices.

Table 4.6: *Interaction of London Dummy with Energy Efficiency and Environmental Impact*

Dependent Variable:	**logpricepsqm**
Log (EEI)	0.032***
	(0.004)
Log (EII)	0.054***
	(0.005)
Log (EEI) * London	0.002
	(0.011)
Log (EII) * London	-0.032**
	(0.014)
Location & Time Fixed Effects	Yes
Control Variables	Yes
Observations	5,010,279
Adjusted R^2	0.743

Note: *** denotes significance at 0.01, ** at 0.05, and * at 0.1.

It is also worth reiterating that London is a global hub where international buyers often seek safe assets for investment purposes. Their primary concern tends to be securing property in a prime location, rather than the environmental performance of the building or the comfort and amenities that may accompany lower environmental impact. It is therefore reasonable to expect that the effect of the environmental impact on property prices would be far more muted in London compared to the rest of the UK.

Extending the same line of reasoning, domestic buyers in London often find themselves acting as price-takers due to the intense competition in the housing market. In such an environment, buyers may be forced to compromise on preferences such as eco-friendly features or luxury add-ons in order to secure a property.

4.3 Robustness Check

4.3.1 Main Heat: Gas Only

Lastly, I re-estimate the previous regressions, this time restricting the sample to properties that use gas as their primary heating source to assess the robustness of the results. It is important to note that fuel types have been aggregated into two categories - "gas" or "other fuels". This aggregation is intended to reduce dimensionality, mitigate collinearity issues, and enhance interpretability. The classification of individual fuel types into these broader categories is detailed in Appendix C.

As previously discussed, both the EEI and the EII are directly linked to the type of fuel used in terms of its cost and CO_2 emissions, respectively. By limiting the sample to properties that use the same primary heating fuel, much of the divergence between these two indices is eliminated.

The results for the gas-only subsample are presented in Table 4.7.

Table 4.7: *Full Regression Outputs across Specifications (Gas-only Subsample)*

Dependent Variable: logpricepsqm	**(1)**	**(2)**	**(3)**	**(4)**
Log (EEI)	0.088***	-0.076*	-0.102***	0.094***
	(0.009)	(0.042)	(0.022)	(0.011)
Log (EII)	-0.002	0.100**	0.233***	0.003
	(0.011)	(0.040)	(0.023)	(0.012)
Log (EEI) * Type: House		0.173***		
		(0.043)		
Log (EII) * Type: House		-0.111**		
		(0.044)		
Log (EEI) * Tenure: Owner-occupied			0.203***	
			(0.019)	
Log (EII) * Tenure: Owner-occupied			-0.252***	
			(0.019)	
Log (EEI) * London				-0.048
				(0.038)
Log (EII) * London				-0.016
				(0.040)
Location & Time Fixed Effects	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	
Observations	4,376,246	3,865,354	4,289,866	4,376,246
Adjusted R^2	0.760	0.765	0.760	0.761

Note: *** denotes significance at 0.01, ** at 0.05, and * at 0.1.

Model (1) provides a clear insight: in the absence of the main source of variation, the attribute that signals cost savings becomes more prominent. As a result, the significant and positive effect of energy efficiency drowns out the environmental impact. This finding reinforces the notion that the market consistently values the direct economic benefits associated with energy efficiency.

When the house dummy is introduced in Model (2), the effects begin to diverge: for flats, there is a weak discount associated with energy efficiency and a strong premium for environmental impact; for houses, the pattern is reversed, with a strong premium for energy efficiency and a weak discount for environmental impact. While one might expect the two indices to move in the same direction once the main variance contributor is removed, these results indicate that secondary systems still exert a significant influence. Although gas is the dominant main heating source, used in 86.2% of properties, among the 2,888,705 properties with known secondary heating sources, gas accounts for only 49.13%, while electricity accounts for 28.98%. This introduces considerable variation in the EII, even within a sample restricted to properties using gas as their main heating source.

Building on this, I would argue that it is highly likely the EII also captures the presence of luxury finishes in this case. For example, when comparing two flats - one equipped with a standard gas combi boiler and the other with an electric hot water system - the EPC framework would penalise the latter in terms of energy efficiency due to the significantly higher cost of grid electricity, which directly affects the energy efficiency score. In contrast, the flat with the gas combi boiler, despite using a dirtier fuel, would receive a higher EER. However, the EII would take the opposite stance: it would reward the system that uses grid electricity and penalize the combi boiler. These types of systems are most prevalent in flats, and where such distinctions are also more likely to matter to prospective buyers, as previously discussed.

Hence, it is plausible that the EII is also picking up signals of higher-end finishes in flats, whereas in houses, simply due to the substantial cost of heating larger spaces, energy efficiency remains a more important driver of buyer preferences. Crucially, those purchasing a “forever home” may consider these types of finishes ubiquitous and straight out of a catalogue.

The same line of reasoning also applies to Model (3). As with the flat versus house dynamic, rental properties tend to be rewarded for higher environmental impact and penalized for energy efficiency, and vice versa for owner-occupied properties. In the case of rental properties, the investor purchasing the asset does not bear the operating costs and is likely to prioritise features that attract desirable tenants and justify higher rents. In contrast, owner-occupiers are directly responsible for ongoing expenses, and the appeal of features like a high-pressure shower or an electric induction hob may be outweighed by the higher associated energy costs.

Moreover, we are likely to observe greater heterogeneity among house-buyers compared to investors, but even more so than that group, owner-occupiers are often looking for a home rather than just a property. Their decision-making process tends to be more complex and emotionally driven. As a result, while cost savings are broadly understood and consistently valued, the more abstract and less tangible attributes reflected in the EII may carry less weight and exhibit greater variability in importance within this group.

Finally, when I control for London, Model (4) shows a statistically significant premium for energy efficiency but no discernible impact for the EII. If my hypothesis regarding the meanings of these metrics is accurate, one might ask why similar results are not observed in London. I argue that this can be attributed to the immense competitiveness and diversity of the London housing market. Prices vary widely across neighbourhoods and property sizes, making it highly likely that the most desirable, headline attributes dominate and drown out more nuanced signals. In this context, once the main source of variation in environmental performance is removed, the small details become largely irrelevant to buyers. However, even in one of the most expensive housing markets in the world, cost savings associated with energy efficiency remain an important consideration, though not one that differs significantly from trends observed in the rest of the country.

5. CONCLUSIONS

It is imperative that we, as humankind, reduce our carbon footprint if we are to ensure our survival. Reforming the built environment is a crucial step toward achieving this goal. The way this challenge is currently addressed in policy tends to be pragmatic but somewhat tangential. In this paper, my aim was to address this gap by turning the spotlight on a neglected component of such policy frameworks, namely CO_2 emissions.

My results demonstrate that the market values the EEI and the EII in fundamentally different ways. While the EEI is consistently appreciated for its cost-saving implications, the EII appears to function as a more complex proxy for intangible qualities, especially in the presence of omitted variables. As discussed, the high degree of collinearity between these two indices makes it difficult to disentangle their individual effects on property prices. To address this, I employed logarithmic transformations; however, it is important to bear in mind that the two variables remain highly correlated even in their logarithmic forms, which should be considered when interpreting the results.

More importantly, the valuation of both the EEI and the EII exhibits significant heterogeneity among different property types, housing tenures, and micro-markets. In both the comparison between houses and flats, and between owner-occupied and rental housing, those seeking to purchase a “home” rather than an investment property appear to place greater value on the cost-saving aspect of energy efficiency. This finding is in line with Ghosh et al. [12]’s conclusion that in areas with longer housing tenure, i.e., where buyers intend to reside in the property for an extended period, the premium they are willing to pay for a higher energy efficiency increases.

For flats, and similarly for rental properties, the EII appears to capture unobserved characteristics such as modernity, high-end finishes, or indicators of a lower-risk asset. This interpretation is further supported by the results in Section 4.3.1, where I isolate properties that use gas as their main heating fuel, thereby significantly limiting variation in both indices. Notably, the observed patterns persist even under these restricted conditions.

A discount for a higher EEI may seem counterintuitive at first, but in contexts where utility bills are already low, a marginal improvement in energy efficiency may be outweighed by other factors, or even be associated with less desirable properties, such as less modern ones or those with fewer amenities.

My findings of an insignificant EEI for rental properties provide strong empirical support for the split incentive problem. A key contribution of this paper to both the existing literature and the broader energy efficiency discourse is the identification of EII as a relevant metric for evaluating investment assets. In the absence of the EII variable, EEI may exhibit a significant and positive coefficient, potentially capturing a general "quality" premium. However, my results suggest that EII serves as a less noisy and more accurate proxy for identifying lower-risk, higher-quality assets. For investors, the primary concern is not the cost-saving benefits, most of which accrue to tenants, but rather the long-term investment quality of the property, which is more effectively captured by the EII.

Crucially, my findings demonstrate that context matters a lot, especially in property markets. In the case of London, the market functions as a dense and highly competitive environment where smaller, more nuanced attributes are overshadowed, and only the strongest, most salient features influence pricing decisions. Nonetheless, I show that cost savings are a universally valued attribute; even in a hyper-competitive market like London, the cost-saving component of EEI continues to retain its relevance and value.

Finally, by restricting the sample to gas-only properties, I am able to isolate the underlying drivers of price variation even more clearly. The results remain robust even when the main source of variation is controlled for.

However, it is important to acknowledge that these findings are neither perfect nor exhaustive. As discussed, analyses of this kind are inherently subject to omitted variable bias, and the interpretation of the EII in this paper clearly reflects that limitation. Crucial unobserved factors, such as amenities, which play a central role in several of my hypotheses, cannot be directly controlled for, thereby constraining the precision and completeness of the results.

In addition to this limitation, the sample is constrained by the fact that tenure data reflect the occupancy status at the time of the EPC assessment rather than at the time of the transaction. As a result, the analysis may not capture a fully accurate representation of the tenure distribution. This concern is further compounded by the relatively low proportion of private rental properties in the sample compared to official statistics, raising questions about the representativeness of the dataset in this regard.

This paper aimed to provide a more nuanced understanding of "green premiums" by proposing a framework to disentangle cost-based attributes from quality-based signals. The findings carry important policy implications for those working toward a greener built environment, as they offer insights into what drives different groups to value sustainability-related features and how incentives might be better aligned with those preferences.

Future research should aim to uncover the underlying drivers of green premiums by incorporating a broader set of property attributes that capture aspects of quality, luxury, and buyer motivation. Additionally, further scholarship should explore other dimensions of heterogeneity, such as how these premiums vary across different environmental policy contexts, shifts in energy prices, and changes in overall market sentiment.

REFERENCES

[1] United Nations Environment Programme, "Global status report for buildings and construction 2024/2025," report, United Nations Environment Programme, 2025.

[2] S. Kelly, "Report on the implementation of the energy performance of buildings directive." https://www.europarl.europa.eu/doceo/document/A-9-2021-0321_EN.html, 2021. Accessed on 2025-07-21.

[3] European Parliament, Council of the European Union, "Directive 2010/31/eu of the european parliament and of the council of 19 may 2010 on the energy performance of buildings (recast)." https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0031, May 2010. Accessed on 2025-07-21.

[4] "The energy performance of buildings (certificates and inspections) (england and wales) regulations 2007." https://www.legislation.gov.uk/uksi/2007/991/part/2/2007-04-19, April 2007. Accessed on 2025-07-23.

[5] "The energy performance of buildings (england and wales) regulations 2012." https://www.legislation.gov.uk/uksi/2012/3118/part/2, January 2013. Accessed on 2025-07-23.

[6] "A guide to energy performance certificates for the marketing, sale and let of dwellings," report, Department for Communities and Local Government, 2017.

[7] F. Fuerst, P. McAllister, A. Nanda, and P. Wyatt, "Does energy efficiency matter to home-buyers? an investigation of epc ratings and transaction prices in england," *Energy Economics*, vol. 48, pp. 145–156, 2015.

[8] P. Cerin, L. Hassel, and N. Semenova, "Energy performance and housing prices," *Sustainable Development*, vol. 22, no. 6, pp. 404–419, 2014.

[9] O. Jensen, A. Hansen, and H. Kragh, "Market response to the public display of energy performance rating at property sales," *Energy Policy*, vol. 93, pp. 229–235, 2016.

[10] E. Aydin, D. Brounen, and N. Kok, "The capitalization of energy efficiency: Evidence from the housing market," *Journal of Urban Economics*, vol. 117, p. 103243, 2020.

[11] J. Palmer, "Epcs as efficiency targets: Lowering emissions, raising standards," report, Passivhaus Trust, 2020.

[12] A. Ghosh, B. McConnel, and J. Mill´an-Quijano, "Do homebuyers value energy efficiency? evidence from an information shock." Unpublished paper, 2024.

[13] K. Lancaster, "A new approach to consumer theory," *Journal of Political Economy*, vol. 74, no. 2, pp. 132–157, 1966.

[14] S. Rosen, "Hedonic prices and implicit markets: Product differentiation in pure competition," *Journal of Political Economy*, vol. 82, no. 1, pp. 34–55, 1974.

[15] G. Debrezion, E. Pels, and P. Rietveld, "The impact of rail transport on real estate prices: An empirical analysis of the dutch housing market," *Urban Studies*, vol. 48, no. 5, pp. 997–1015, 2011.

[16] D. Brasington and D. Haurin, "Educational outcomes and house values: A test of the value added approach," *Journal of Regional Science*, vol. 46, no. 2, pp. 245–268, 2006.

[17] T. Clauretie and M. Wolverton, "Leave vacant or rent: The optimal decision for absentee home sellers," *Journal of Real Estate Research*, vol. 28, no. 1, pp. 25–38, 2006.

[18] J. Henning and R. Ridker, "The determinants of residential property values with special reference to air pollution," *The Review of Economics and Statistics*, vol. 49, no. 2, pp. 246–257, 1967.

[19] L. Zhang and T. Leonard, "Flood hazards impact on neighborhood house prices," *Journal of Real Estate Finance and Economics*, vol. 58, pp. 656–674, 2018.

[20] M. McCord, S. MacIntyre, P. Bidanset, D. Lo, and P. Davis, "Examining the spatial relationship between environmental health factors and house prices: No2 problem?," *Journal of European Real Estate Research*, vol. 11, no. 3, pp. 353–398, 2018.

[21] J. Hansen, E. Benson, and D. Hagen, "Environmental hazards and residential property values: Evidence from a major pipeline event," *Land Economics*, vol. 82, no. 4, pp. 529–541, 2006.

[22] P. Linneman, "Some empirical results on the nature of the hedonic price function for the urban housing market," *Journal of Urban Economics*, vol. 8, pp. 47–68, 1980.

[23] "Sap 10.2 the government's standard assessment procedure for energy rating of dwellings," report, BRE, 2023.

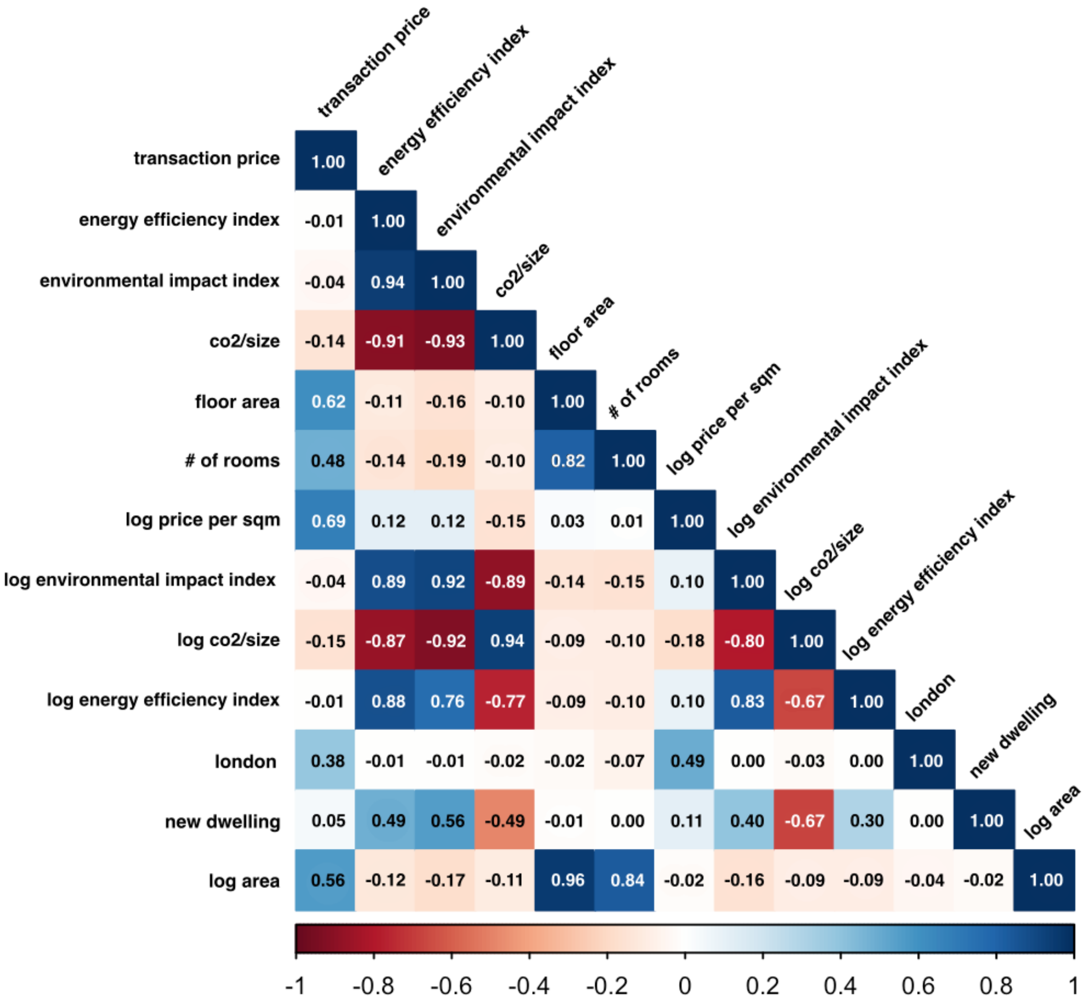
[24] L. Castellazzi, P. Bertoldi, and M. Economidou, "Overcoming the split incentive barrier in the building sector," report, European Commission, 2017.

[25] Ministry of Housing, Communities and Local Government, "Chapter 1: Profile of households and dwellings." `https://www.gov.uk/government/statistics/chapters-for-english-housing-survey-2023-to-2024-headline-findings-on-demographics-and-household-resilience/chapter-1-profile-of-households-and-dwellings`, Nov 2024. Accessed on 2025-07-25.

APPENDICES

APPENDIX A. CORRELATION MATRIX

Figure A.1: *Correlation matrix of numeric variables*



APPENDIX B. REGRESSION RESULTS

Table B.1: Energy Efficiency Regressions

Dependent Variable: logpricepersqm	(1)	(2)	(3)
Rating: A	0.025***		
	(0.008)		
Rating: B	0.014**		
	(0.007)		
Rating: C	0.011***		
	(0.002)		
Rating: E	-0.025***		
	(0.002)		
Rating: F	-0.053***		
	(0.004)		
Rating: G	-0.140***		
	(0.006)		
EEI		0.002***	
		(0.0001)	
Log (EEI)			0.066***
			(0.003)
Log (Area)	-0.349***	-0.349***	-0.349***
	(0.010)	(0.010)	(0.010)
# of Rooms	0.042***	0.042***	0.042***
	(0.003)	(0.003)	(0.003)
Age: Pre-1900	0.053***	0.060***	0.053***
	(0.011)	(0.010)	(0.011)
Age: 1900–1929	-0.049***	-0.042***	-0.049***
	(0.011)	(0.010)	(0.011)
Age: 1930–1966	-0.057***	-0.053***	-0.057***
	(0.008)	(0.007)	(0.008)
Age: 1967–1995	-0.017**	-0.015**	-0.017**
	(0.008)	(0.007)	(0.008)
Age: 1996–2023	0.052***	0.046***	0.053***
	(0.010)	(0.009)	(0.010)
Type: Bungalow	0.145	0.134	0.135
	(0.088)	(0.087)	(0.093)
Type: Flat	-0.148*	-0.164*	-0.158*
	(0.088)	(0.087)	(0.093)
Type: House	0.006	-0.006	-0.004
	(0.088)	(0.087)	(0.093)
Type: Maisonette	-0.168*	-0.182**	-0.177*
	(0.088)	(0.087)	(0.093)
Tenure: Owner-occupied	0.051***	0.051***	0.051***
	(0.005)	(0.005)	(0.005)
Tenure: Rental (Private)	-0.0008	-0.0006	-0.0009
	(0.005)	(0.005)	(0.005)
Built Form: Detached	0.225***	0.227***	0.225***
	(0.012)	(0.012)	(0.012)
Built Form: Enclosed End-Terrace	-0.054***	-0.055***	-0.055***
	(0.015)	(0.015)	(0.015)
Built Form: Enclosed Mid-Terrace	-0.152***	-0.155***	-0.153***
	(0.036)	(0.035)	(0.036)
Built Form: End-Terrace	-0.080***	-0.079***	-0.080***
	(0.010)	(0.010)	(0.010)
Built Form: Mid-Terrace	-0.126***	-0.127***	-0.126***
	(0.011)	(0.011)	(0.011)
Built Form: Semi-Detached	0.050***	0.051***	0.050***
	(0.011)	(0.011)	(0.011)
New Dwelling	-0.021	-0.022	-0.021
	(0.015)	(0.015)	(0.015)
Fuel: Gas	0.091***	0.106***	0.072***
	(0.006)	(0.008)	(0.007)
Fuel: Other	0.154***	0.170***	0.133***
	(0.007)	(0.008)	(0.007)
Location & Time Fixed Effects	Yes	Yes	Yes
Observations	5,010,279	5,010,279	5,010,279
Adjusted R^2	0.742	0.742	0.742

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.2: Energy Efficiency and Environmental Impact Effects on Property Prices

Dependent Variable: logpricepersqm	**(1)**	**(2)**	**(3)**	**(4)**
EEI	0.0003	-0.001***		
	(0.0002)	(0.0003)		
EII	0.002***			
	(0.0002)			
CO_2/Size		-0.002***		
		(0.0002)		
Log (EEI)			0.032***	0.033***
			(0.004)	(0.003)
Log (EII)			0.051***	
			(0.005)	
Log (CO_2/Size)				-0.064***
				(0.006)
Log (Area)	-0.345***	-0.381***	-0.347***	-0.366***
	(0.010)	(0.011)	(0.010)	(0.010)
# of Rooms	0.042***	0.042***	0.042***	0.042***
	(0.003)	(0.002)	(0.003)	(0.003)
Age: Pre-1900	0.063***	0.062***	0.058***	0.067***
	(0.009)	(0.010)	(0.010)	(0.009)
Age: 1900–1929	-0.038***	-0.039***	-0.044***	-0.035***
	(0.010)	(0.010)	(0.011)	(0.010)
Age: 1930–1966	-0.050***	-0.051***	-0.054***	-0.049***
	(0.007)	(0.007)	(0.008)	(0.007)
Age: 1967–1995	-0.014**	-0.015**	-0.016**	-0.013**
	(0.007)	(0.007)	(0.008)	(0.006)
Age: 1996–2023	0.042***	0.041***	0.049***	0.039***
	(0.009)	(0.009)	(0.009)	(0.008)
Type: Bungalow	0.140	0.146*	0.138	0.135
	(0.086)	(0.085)	(0.089)	(0.089)
Type: Flat	-0.160*	-0.153*	-0.159*	-0.166*
	(0.086)	(0.085)	(0.089)	(0.089)
Type: House	-0.0005	0.005	-0.002	-0.005
	(0.086)	(0.085)	(0.089)	(0.089)
Type: Maisonette	-0.178**	-0.172**	-0.177*	-0.183**
	(0.086)	(0.085)	(0.090)	(0.089)
Tenure: Owner-occupied	0.050***	0.050***	0.050***	0.050***
	(0.005)	(0.005)	(0.005)	(0.005)
Tenure: Rental (Private)	-0.0006	-0.0005	-0.002	-0.0007
	(0.005)	(0.005)	(0.005)	(0.005)
Built Form: Detached	0.227***	0.225***	0.226***	0.227***
	(0.012)	(0.012)	(0.012)	(0.012)
Built Form: Enclosed End-Terrace	-0.055***	-0.055***	-0.056***	-0.056***
	(0.015)	(0.016)	(0.015)	(0.015)
Built Form: Enclosed Mid-Terrace	-0.156***	-0.160***	-0.155***	-0.159***
	(0.035)	(0.035)	(0.035)	(0.035)
Built Form: End-Terrace	-0.079***	-0.082***	-0.079***	-0.080***
	(0.010)	(0.010)	(0.010)	(0.010)
Built Form: Mid-Terrace	-0.128***	-0.132***	-0.127***	-0.130***
	(0.011)	(0.011)	(0.011)	(0.011)
Built Form: Semi-Detached	0.051***	0.048***	0.051***	0.050***
	(0.011)	(0.011)	(0.011)	(0.011)
New Dwelling	-0.023	-0.024	-0.022	-0.024
	(0.015)	(0.015)	(0.015)	(0.015)
Fuel: Gas	0.126***	0.124***	0.094***	0.088***
	(0.007)	(0.007)	(0.006)	(0.007)
Fuel: Other	0.195***	0.204***	0.164***	0.162***
	(0.008)	(0.008)	(0.008)	(0.008)
Location & Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	5,010,279	5,010,279	5,010,279	5,010,279
Adjusted R^2	0.743	0.743	0.743	0.743

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.3: Interaction of Property Type with Energy Efficiency and Environmental Impact

Dependent Variable:	**logpricepsqm**
Log (EEI)	-0.033*** (0.011)
Log (EII)	0.129*** (0.013)
Type: House	0.206*** (0.045)
Log (EEI) * Type: House	0.074*** (0.011)
Log (EII) * Type: House	-0.087*** (0.013)
Log (Area)	-0.333*** (0.010)
# of Rooms	0.041*** (0.003)
Age: Pre-1900	0.052*** (0.010)
Age: 1900–1929	-0.045*** (0.010)
Age: 1930–1966	-0.054*** (0.007)
Age: 1967–1995	-0.017** (0.008)
Age: 1996–2023	0.046*** (0.009)
Tenure: Owner-occupied	0.054*** (0.005)
Tenure: Rental (Private)	0.002 (0.005)
Built Form: Detached	0.228*** (0.012)
Built Form: Enclosed End-Terrace	-0.058*** (0.015)
Built Form: Enclosed Mid-Terrace	-0.158*** (0.035)
Built Form: End-Terrace	-0.082*** (0.010)
Built Form: Mid-Terrace	-0.129*** (0.010)
Built Form: Semi-Detached	0.043*** (0.011)
New Dwelling	-0.024 (0.017)
Fuel: Gas	0.091*** (0.007)
Fuel: Other	0.168*** (0.008)
Location & Time Fixed Effects	Yes
Observations	4,397,102
Adjusted R^2	0.748

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.4: Interaction of Tenure with Energy Efficiency and Environmental Impact

Dependent Variable:	**logpricepsqm**
Log (EEI)	0.002
	(0.008)
Log (EII)	0.115***
	(0.011)
Tenure: Owner-occupied	0.198***
	(0.037)
Log (EEI) * Tenure: Owner-occupied	0.032***
	(0.007)
Log (EII) * Tenure: Owner-occupied	-0.069***
	(0.011)
Log (Area)	-0.347***
	(0.010)
# of Rooms	0.042***
	(0.003)
Age: Pre-1900	0.059***
	(0.010)
Age: 1900–1929	-0.042***
	(0.010)
Age: 1930–1966	-0.053***
	(0.007)
Age: 1967–1995	-0.016**
	(0.007)
Age: 1996–2023	0.048***
	(0.009)
Type: Bungalow	0.129
	(0.092)
Type: Flat	-0.169*
	(0.092)
Type: House	-0.009
	(0.092)
Type: Maisonette	-0.185**
	(0.092)
Built Form: Detached	0.224***
	(0.012)
Built Form: Enclosed End-Terrace	-0.056***
	(0.015)
Built Form: Enclosed Mid-Terrace	-0.156***
	(0.035)
Built Form: End-Terrace	-0.081***
	(0.010)
Built Form: Mid-Terrace	-0.128***
	(0.011)
Built Form: Semi-Detached	0.049***
	(0.011)
New Dwelling	-0.022
	(0.015)
Fuel: Gas	0.095***
	(0.006)
Fuel: Other	0.165***
	(0.008)
Location & Time Fixed Effects	Yes
Observations	4,908,312
Adjusted R^2	0.742

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.5: Interaction of London Dummy with Energy Efficiency and Environmental Impact

Dependent Variable:	**logpricepsqm**
Log (EEI)	0.032***
	(0.004)
Log (EIIx)	0.054***
	(0.005)
Log (EEI) * London	0.002
	(0.011)
Log (EII) * London	-0.032**
	(0.014)
Log (Area)	-0.347***
	(0.010)
# of Rooms	0.042***
	(0.003)
Age: Pre-1900	0.058***
	(0.010)
Age: 1900–1929	-0.044***
	(0.011)
Age: 1930–1966	-0.054***
	(0.008)
Age: 1967–1995	-0.017**
	(0.008)
Age: 1996–2023	0.048***
	(0.009)
Type: Bungalow	0.140
	(0.088)
Type: Flat	-0.156*
	(0.088)
Type: House	0.0004
	(0.088)
Type: Maisonette	-0.174*
	(0.088)
Tenure: Owner-occupied	0.050***
	(0.005)
Tenure: Rental (Private)	-0.002
	(0.005)
Built Form: Detached	0.226***
	(0.012)
Built Form: Enclosed End-Terrace	-0.056***
	(0.015)
Built Form: Enclosed Mid-Terrace	-0.155***
	(0.035)
Built Form: End-Terrace	-0.080***
	(0.010)
Built Form: Mid-Terrace	-0.127***
	(0.011)
Built Form: Semi-Detached	0.050***
	(0.011)
New Dwelling	-0.022
	(0.015)
Fuel: Gas	0.095***
	(0.007)
Fuel: Other	0.165***
	(0.008)
Location & Time Fixed Effects	Yes
Observations	5,010,279
R^2	0.743

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.6: Full Regression Outputs across Specifications (Gas-only subsample)

Dependent Variable: logpricepersqm	**(1)**	**(2)**	**(3)**	**(4)**
Log (EEI)	0.088*** (0.009)	-0.076* (0.042)	-0.102*** (0.022)	0.094*** (0.011)
Log (EII)	-0.002 (0.011)	0.100** (0.040)	0.233*** (0.023)	0.003 (0.012)
Log (EEI) * Type: House		0.173*** (0.043)		
Log (EII) * Type: House		-0.111** (0.044)		
Log (EEI) * Tenure: Owner-occupied			0.203*** (0.019)	
Log (EII) * Tenure: Owner-occupied			-0.252*** (0.019)	
Log (EEI) * London				-0.048 (0.038)
Log (EII) * London				-0.016 (0.040)
Log (Area)	-0.366*** (0.010)	-0.353*** (0.010)	-0.366*** (0.010)	-0.366*** (0.010)
# of Rooms	0.043*** (0.002)	0.042*** (0.002)	0.043*** (0.002)	0.043*** (0.002)
Age: Pre-1900	0.044*** (0.010)	0.039*** (0.010)	0.045*** (0.010)	0.044*** (0.010)
Age: 1900-1929	-0.042*** (0.010)	-0.044*** (0.010)	-0.040*** (0.010)	-0.041*** (0.010)
Age: 1930-1966	-0.050*** (0.007)	-0.050*** (0.007)	-0.050*** (0.007)	-0.050*** (0.007)
Age: 1967-1995	-0.004 (0.007)	-0.006 (0.008)	-0.004 (0.007)	-0.004 (0.007)
Age: 1996-2023	0.057*** (0.009)	0.056*** (0.009)	0.057*** (0.009)	0.056*** (0.009)
Type: House	-0.053 (0.192)	-0.129 (0.077)	-0.053 (0.192)	-0.054 (0.191)
Type: Bungalow	0.095 (0.192)		0.094 (0.193)	0.093 (0.192)
Type: Flat	-0.191 (0.192)		-0.194 (0.193)	-0.191 (0.192)
Type: Maisonette	-0.222 (0.192)		-0.222 (0.193)	-0.222 (0.192)
Tenure: Owner-occupied	0.052*** (0.005)	0.057*** (0.006)	0.248*** (0.059)	0.052*** (0.005)
Tenure: Rental (Private)	-0.007 (0.005)	-0.004 (0.006)		-0.007 (0.005)
Built Form: Detached	0.221*** (0.012)	0.224*** (0.013)	0.219*** (0.012)	0.221*** (0.012)
Built Form: Enclosed End-Terrace	-0.060*** (0.022)	-0.060*** (0.023)	-0.062*** (0.022)	-0.060*** (0.022)
Built Form: Enclosed Mid-Terrace	-0.199*** (0.050)	-0.199*** (0.050)	-0.200*** (0.049)	-0.197*** (0.050)
Built Form: End-Terrace	-0.081*** (0.011)	-0.083*** (0.011)	-0.083*** (0.010)	-0.081*** (0.010)
Built Form: Mid-Terrace	-0.125*** (0.011)	-0.126*** (0.011)	-0.126*** (0.011)	-0.125*** (0.011)
Built Form: Semi-Detached	0.053*** (0.011)	0.047*** (0.011)	0.050*** (0.011)	0.052*** (0.011)
New Dwelling	-0.025 (0.015)	-0.028 (0.017)	-0.025 (0.016)	-0.025 (0.015)
Location & Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	4,376,246	3,865,354	4,289,866	4,376,246
Adjusted R^2	0.760	0.765	0.760	0.761

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

APPENDIX C. CATEGORIZATION OF FUEL TYPES

Figure C.1: *Categorization of Main Heating Fuel Types*

Main Heat Description	Initial Category	Final Category
mains gas (not community)	Gas	Gas
mains gas - this is for backwards compatibility only and should not be used	Gas	Gas
Gas: mains gas	Gas	Gas
LPG (not community)	LPG	Other Fuel
LPG - this is for backwards compatibility only and should not be used	LPG	Other Fuel
bottled LPG	LPG	Other Fuel
Gas: bulk LPG	LPG	Other Fuel
LPG special condition	LPG	Other Fuel
Gas: bottled LPG	LPG	Other Fuel
LNG	LPG	Other Fuel
oil - this is for backwards compatibility only and should not be used	Oil	Other Fuel
oil (not community)	Oil	Other Fuel
Oil: heating oil	Oil	Other Fuel
B30K (not community)	Oil	Other Fuel
appliances able to use mineral oil or liquid biofuel	Oil	Other Fuel
biodiesel from any biomass source	Oil	Other Fuel
electricty (not community)	Electricity	Other Fuel
electricity - this is for backwards compatibility only and should not be used	Electricity	Other Fuel
Electricity: electricity, unspecified tariff	Electricity	Other Fuel
smokeless coal	Solid Fuel	Other Fuel
dual fuel - mineral + wood	Solid Fuel	Other Fuel
house coal (not community)	Solid Fuel	Other Fuel
anthracite	Solid Fuel	Other Fuel
house coal - this is for backwards compatibility only and should not be used	Solid Fuel	Other Fuel
Solid fuel: dual fuel appliance (mineral and wood)	Solid Fuel	Other Fuel
Solid fuel: house coal	Solid Fuel	Other Fuel
wood logs	Biomass	Other Fuel
wood chips	Biomass	Other Fuel
bulk wood pellets	Biomass	Other Fuel
biomass - this is for backwards compatibility only and should not be used	Biomass	Other Fuel
Solid fuel: wood logs	Biomass	Other Fuel
biogas (not community)	Biomass	Other Fuel
wood pellets in bags for secondary heating	Biomass	Other Fuel
bioethanol	Biomass	Other Fuel
Solid fuel: wood pellets (bulk supply in bags, for main heating)	Biomass	Other Fuel
mains gas (community	Community	Other Fuel
biogas - landfill - this is for backwards compatibility only and should not be used	Community	Other Fuel
B30D (community)	Community	Other Fuel
biomass (community)	Community	Other Fuel
oil (community)	Community	Other Fuel
electricity (community)	Community	Other Fuel
from heat network data (community)	Community	Other Fuel
waste combustion (community)	Community	Other Fuel
heat from boilers using biodiesel from any biomass source (community)	Community	Other Fuel
Community heating schemes: heat from boilers - biomass	Community	Other Fuel
waste combustion - this is for backwards compatibility only and should not be used	Community	Other Fuel
LPG (community)	Community	Other Fuel
biogas (community)	Community	Other Fuel
coal (community)	Community	Other Fuel
To be used when there is no heating/hot-water system	No Heating	No Heating
To be used only when there is no heating/hot-water system or data is from a community network	No Heating	No Heating
NO DATA!	Unknown	Unknown
INVALID!	Unknown	Unknown
""	Unknown	Unknown

Figure C.2: *Categorization of Secondary Heating Fuel Types*

<table>
<tr><th>Second Heat Description</th><th>Category</th></tr>
<tr><td>Room heaters, mains gas</td><td>Gas</td></tr>
<tr><td>Room heaters, electric</td><td>Electricity</td></tr>
<tr><td>Room heaters, dual fuel (mineral and wood)</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters, wood logs</td><td>Biomass</td></tr>
<tr><td>Portable electric heaters (assumed)</td><td>Electricity</td></tr>
<tr><td>Room heaters, coal</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters, smokeless fuel</td><td>Solid Fuel</td></tr>
<tr><td>Portable electric heaters</td><td>Electricity</td></tr>
<tr><td>SAP05:Secondary-Heating</td><td>Unknown</td></tr>
<tr><td>Room heaters, LPG</td><td>LPG</td></tr>
<tr><td>Room heaters, anthracite</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters, oil</td><td>Oil</td></tr>
<tr><td>None|Dim</td><td>No Heating</td></tr>
<tr><td>Room heaters, bottled gas</td><td>Gas</td></tr>
<tr><td>Room heaters, wood pellets</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters, wood chips</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters, bioethanol</td><td>Biomass</td></tr>
<tr><td>Room heaters, lpg</td><td>LPG</td></tr>
<tr><td>Room heaters,</td><td>Unknown</td></tr>
<tr><td>Room heaters, |Gwresogyddion ystafell, |electric|trydan</td><td>Electricity</td></tr>
<tr><td>Portable electric heaters(assumed)</td><td>Electricity</td></tr>
<tr><td>Room heaters, bottled LPG</td><td>LPG</td></tr>
<tr><td>Dim</td><td>No Heating</td></tr>
<tr><td>Room heaters,</td><td>Unknown</td></tr>
<tr><td>Room heaters, |Gwresogyddion ystafell, |mains gas|nwy prif gyflenwad</td><td>Gas</td></tr>
<tr><td>Electric Underfloor Heating (Standard tariff), electric</td><td>Electricity</td></tr>
<tr><td>Room heaters, (null)</td><td>None</td></tr>
<tr><td>Gas/LPG boiler 1998 or later, gas</td><td>Gas</td></tr>
<tr><td>Gas/LPG boiler pre-1998 with balanced or open-flue, gas</td><td>Gas</td></tr>
<tr><td>Gwresogyddion ystafell, nwy prif gyflenwad</td><td>Gas</td></tr>
<tr><td>Room heaters</td><td>Unknown</td></tr>
<tr><td>Room heaters, heating oil</td><td>Oil</td></tr>
<tr><td>Room heaters, main wood pellets</td><td>Biomass</td></tr>
<tr><td>Hot-Water-Only Systems, gas</td><td>Gas</td></tr>
<tr><td>Room heaters, |Gwresogyddion ystafell, |wood logs|logiau coed</td><td>Biomass</td></tr>
<tr><td>Room heaters, bulk LPG</td><td>LPG</td></tr>
<tr><td>Room heaters, B30K</td><td>Oil</td></tr>
<tr><td>Room heaters, wood pellets (bags)</td><td>Solid Fuel</td></tr>
<tr><td>Gwresogyddion ystafell, trydan</td><td>Electricity</td></tr>
<tr><td>Gwresogyddion ystafell, logiau coed</td><td>Biomass</td></tr>
<tr><td>Room heaters, secondary wood pellets</td><td>Biomass</td></tr>
<tr><td>LPG room heaters, gas</td><td>Gas</td></tr>
<tr><td>Room heaters, LNG</td><td>LPG</td></tr>
<tr><td>Room heaters, smokeless Fuel</td><td>Solid Fuel</td></tr>
<tr><td>Gas/LPG boiler pre-1998, with fan-assisted flue, gas</td><td>Gas</td></tr>
<tr><td>Room heaters, bulk wood pellets</td><td>Solid Fuel</td></tr>
<tr><td>Gwresogyddion trydan cludadwy (rhagdybiaeth)</td><td>Electricity</td></tr>
<tr><td>Gwresogyddion ystafell, dau danwydd (mwynau a choed)</td><td>Solid Fuel</td></tr>
<tr><td>Electric ceiling heating</td><td>Electricity</td></tr>
<tr><td>Hot-Water-Only Systems, electric</td><td>Electricity</td></tr>
<tr><td>Room heaters, |Gwresogyddion ystafell, |coal|glo</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters???mains gas</td><td>Gas</td></tr>
<tr><td>Room heaters, 13</td><td>Unknown</td></tr>
<tr><td>Gwresogyddion ystafell, coal</td><td>Solid Fuel</td></tr>
<tr><td>Community scheme</td><td>Other</td></tr>
<tr><td>Gwresogyddion ystafell, dual fuel (mineral and wood)</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters, rapeseed oil</td><td>Oil</td></tr>
<tr><td>Gas/LPG CPSU, gas</td><td>Gas</td></tr>
<tr><td>Room heaters, |Gwresogyddion ystafell, |dual fuel (mineral and wood)|dau danwydd (mwynau a choed)</td><td>Solid Fuel</td></tr>
<tr><td>Room heaters, bioethanol from any biomass source</td><td>Biomass</td></tr>
<tr><td>Room heaters???electric</td><td>Electricity</td></tr>
<tr><td>Gwresogyddion ystafell, electric</td><td>Electricity</td></tr>
<tr><td>Other Space Heating Systems, electric</td><td>Electricity</td></tr>
<tr><td>,</td><td>Unknown</td></tr>
<tr><td>Gwresogyddion ystafell, glo</td><td>Solid Fuel</td></tr>
</table>

APPENDIX D. EXAMPLE EPC

Figure D.1: *Example EPC*

Energy Performance Certificate (EPC)

SAP

17 Any Street, District, Any Town, B5 5XX

Dwelling type:	Detached house	**Reference number:**	0919-9628-8430-2785-5996
Date of assessment:	15 August 2011	**Type of assessment:**	RdSAP, existing dwelling
Date of certificate:	13 March 2012	**Total floor area:**	165 m²

Use this document to:

- Compare current ratings of properties to see which properties are more energy efficient
- Find out how you can save energy and money by installing improvement measures

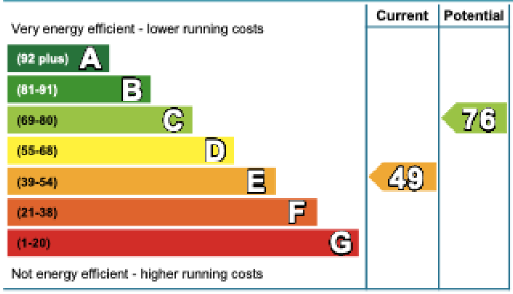
Estimated energy costs of dwelling for 3 years	**£5,367**
Over 3 years you could save	**£2,865**

Estimated energy costs of this home

	Current costs	Potential costs	Potential future savings
Lighting	£375 over 3 years	£207 over 3 years	You could save £2,865 over 3 years
Heating	£4,443 over 3 years	£2,073 over 3 years	
Hot water	£549 over 3 years	£222 over 3 years	
Totals:	**£5,367**	**£2,502**	

These figures show how much the average household would spend in this property for heating, lighting and hot water. This excludes energy use for running appliances like TVs, computers and cookers, and any electricity generated by microgeneration.

Energy Efficiency Rating



The graph shows the current energy efficiency of your home.

The higher the rating the lower your fuel bills are likely to be.

The potential rating shows the effect of undertaking the recommendations on page 3.

The average energy efficiency rating for a dwelling in England and Wales is band D (rating 60).

Top actions you can take to save money and make your home more efficient

Recommended measures	Indicative cost	Typical savings over 3 years	Available with Green Deal
1 Increase loft insulation to 270 mm	£100 - £350	£141	✔
2 Cavity wall insulation	£500 - £1,500	£537	✔
3 Draught proofing	£80 - £120	£78	✔

See page 3 for a full list of recommendations for this property.

To find out more about the recommended measures and other actions you could take today to save money, visit **www.direct.gov.uk/savingenergy** or call **0300 123 1234** (standard national rate). When the Green Deal launches, it may allow you to make your home warmer and cheaper to run at no up-front cost.

Page 1 of 4

17 Any Street, District, Any Town, B5 5XX
13 March 2012 RRN: 0919-9628-8430-2785-5996 **Energy Performance Certificate**

Summary of this home's energy performance related features

Element	Description	Energy Efficiency
Walls	Cavity wall, as built, partial insulation (assumed)	★★★☆☆
Roof	Pitched, 75 mm loft insulation	★★★☆☆
Floor	Solid, no insulation (assumed)	–
Windows	Partial double glazing	★★☆☆☆
Main heating	Boiler and radiators, mains gas	★★★☆☆
Main heating controls	Programmer, room thermostat and TRVs	★★★★☆
Secondary heating	None	–
Hot water	From main system	★★★☆☆
Lighting	Low energy lighting in 17% of fixed outlets	★★☆☆☆

Current primary energy use per square metre of floor area: 298 kWh/m² per year

The assessment does not take into consideration the physical condition of any element. 'Assumed' means that the insulation could not be inspected and an assumption has been made in the methodology based on age and type of construction.

Low and zero carbon energy sources

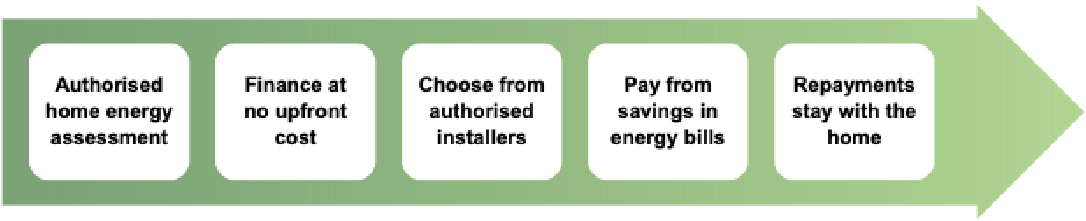
Low and zero carbon energy sources are sources of energy that release either very little or no carbon dioxide into the atmosphere when they are used. Installing these sources may help reduce energy bills as well as cutting carbon. There are none provided for this home.

Opportunity to benefit from a Green Deal on this property

When the Green Deal launches, it may enable tenants or owners to improve the property they live in to make it more energy efficient, more comfortable and cheaper to run, without having to pay for the work upfront. To see which measures are recommended for this property, please turn to page 3. You can choose which measures you want and ask for a quote from an authorised Green Deal provider. They will organise installation by an authorised installer. You pay for the improvements over time through your electricity bill, at a level no greater than the estimated savings to energy bills. If you move home, the Green Deal charge stays with the property and the repayments pass to the new bill payer.

For householders in receipt of income-related benefits, additional help may be available.

To find out more, visit **www.direct.gov.uk/savingenergy** or call **0300 123 1234**.



Recommendations

The measures below will improve the energy performance of your dwelling. The performance ratings after improvements listed below are cumulative; that is, they assume the improvements have been installed in the order that they appear in the table. Further information about the recommended measures and other simple actions you could take today to save money is available at **www.direct.gov.uk/savingenergy**. Before installing measures, you should make sure you have secured the appropriate permissions, where necessary. Such permissions might include permission from your landlord (if you are a tenant) or approval under Building Regulations for certain types of work.

Measures with a green tick ✓ are likely to be fully financed through the Green Deal, when the scheme launches, since the cost of the measures should be covered by the energy they save. Additional support may be available for homes where solid wall insulation is recommended. If you want to take up measures with an orange tick ✓, be aware you may need to contribute some payment up-front.

Recommended measures	Indicative cost	Typical savings per year	Rating after improvement	Green Deal finance
Increase loft insulation to 270 mm	£100 - £350	£47	E 51	✓
Cavity wall insulation	£500 - £1,500	£179	D 59	✓
Draught proofing	£80 - £120	£26	D 60	✓
Low energy lighting for all fixed outlets	£50	£43	D 61	
Replace boiler with new condensing boiler	£2,200 - £3,000	£339	C 74	✓
Solar water heating	£4,000 - £6,000	£34	C 75	✓
Replace single glazed windows with low-E double glazing	£3,300 - £6,500	£41	C 76	✓

Alternative measures

There are alternative measures below which you could also consider for your home.

- External insulation with cavity wall insulation
- Biomass boiler (Exempted Appliance if in Smoke Control Area)
- Air or ground source heat pump
- Micro CHP

Choosing the right package

Visit **www.epcadviser.direct.gov.uk**, our online tool which uses information from this EPC to show you how to save money on your fuel bills. You can use this tool to personalise your Green Deal package.

Directgov
Public services all in one place

Green Deal package	Typical annual savings
Loft insulation	**Total savings of £587**
Cavity wall insulation	
Draught proofing	
Condensing boiler	
Electricity/gas/other fuel savings	£0 / £587 / £0

You could finance this package of measures under the Green Deal. It could **save you £587 a year** in energy costs, based on typical energy use. Some or all of this saving would be recouped through the charge on your bill.

About this document

The Energy Performance Certificate for this dwelling was produced following an energy assessment undertaken by a qualified assessor, accredited by AAA Energy Assessors Ltd. You can get contact details of the accreditation scheme at www.aaa.co.uk, together with details of their procedures for confirming authenticity of a certificate and for making a complaint. A copy of this EPC has been lodged on a national register. It will be publicly available and some of the underlying data may be shared with others for the purposes of research, compliance and direct mailing of relevant energy efficiency information. The current property owner and/or tenant may opt out of having this information disclosed.

Assessor's accreditation number:	AAA_123456
Assessor's name:	John Smith
Phone number:	030 5555 1234
E-mail address:	john.smith@isp.net
Related party disclosure:	No related party

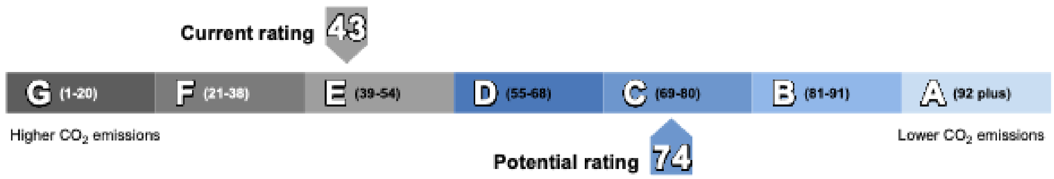
Further information about Energy Performance Certificates can be found under Frequently Asked Questions at **www.epcregister.com**.

About the impact of buildings on the environment

One of the biggest contributors to global warming is carbon dioxide. The energy we use for heating, lighting and power in homes produces over a quarter of the UK's carbon dioxide emissions.

The average household causes about 6 tonnes of carbon dioxide every year. Based on this assessment, your home currently produces approximately 9.5 tonnes of carbon dioxide every year. Adopting the recommendations in this report can reduce emissions and protect the environment. If you were to install these recommendations you could reduce this amount by 5.5 tonnes per year. You could reduce emissions even more by switching to renewable energy sources.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.



Your home's heat demand

For most homes, the vast majority of energy costs derive from heating the home. Where applicable, this table shows the energy that could be saved in this property by insulating the loft and walls, based on typical energy use (shown within brackets as it is a reduction in energy use).

Heat demand	Existing dwelling	Impact of loft insulation	Impact of cavity wall insulation	Impact of solid wall insulation
Space heating (kWh per year)	22,154	(1179)	(4535)	N/A
Water heating (kWh per year)	2,792			

Addendum

This dwelling may have narrow cavities and so requires further investigation to determine which type of cavity wall insulation is best suited.