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# On the capitalization of energy labels on the French housing market

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## Abstract

A COMPLETE (ABSTRACT)

**Keywords:** Energy renovation, Energy efficiency, Household behavior

**JEL Codes:** A COMPLETE

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# 1 Introduction

In France, the building sector is one of the most energy intensive, emitting more than 123 million tons of CO<sub>2</sub> each year, which account for 27% of the country's national emissions, and 44% of its energy consumption<sup>1</sup>. Most of this energy is due to heating, cooling and lighting equipment. Energy retrofits and renovation of households have emerged as a necessary solution to reduce building's consumption and meet with the French government's objective of dividing emissions by 4 by 2050.

Standards in terms of energy efficiency have tightened, at the European level, mainly following the Energy Efficiency Directive (EED) that requires EU countries to collectively engage to a reduction of 13% of energy consumption by 2030, with 2020 energy consumption as a baseline. In France, energy labels for residential buildings inherited from the EU Energy Performance of Buildings Directive (EPBD), are part of this policy, under the form of Energy Performance Certificates<sup>2</sup>. They are mandatory since 2006<sup>3</sup> for every transaction having place on the housing market as well as, most recently, on the rental market. The French EPC has evolved over the years, and now includes a new computation method uncorrelated with households' behavior as well as an estimation of CO<sub>2</sub> emissions. It offers owners, buyers, landlords and tenants a reliable reference scale on which to situate their housing. From January 2023, EPC ranks are used to excludes leaky homes (rank "G" dwellings that consume more than 420 kWh/m<sup>2</sup>·year from the rental market, a measure intended to encourage homeowners to energy, but that really concern landlords more than owners that occupy their own housing. French government's policy is planned to tighten even more, with progressively increasing restriction to an objective of no rank "E" dwellings on the rental market by 2034.

Although the utility of EPCs is not to be discussed, they raise the question of energy retrofits and renovation in France. France is indeed far from meeting its own setted objective of 1% of buildings being labeled highly energy efficient<sup>4</sup>, only being able to labelize 0.2% of dwellings, according to the High Council of Climate (HCC). Near 20% of the housing stock are F and G housings (the two worst ranks), against a small 10% for energy efficient A and B buildings.

Energy retrofit investments efficiency is discussed in [Allcott and Greenstone \(2012\)](#), [Allcott \(2011\)](#), [Fowle et al. \(2018\)](#), and may not be high enough for households to be incited to renovate their housing. In France, several studies conducted by [ADEME \(2021\)](#) find evidence that energy retrofits appear in the case of a full dwelling renovation, that may imply high costs (tens of thousands of euros). With the average duration of ownership in France being around 10 years in 2017, according to notarial institutes, the repayment duration of renovation might be too long for homeowners to enter the profitability period of their investment ([Walls et al. \(2017\)](#)). This phenomenon, although it suffers from a lack of serious studies, is often cited as an explanation for under-investment in

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<sup>1</sup>According to the French Ministry of Ecological Transition and Territorial Cohesion

<sup>2</sup>In French, "*Diagnostic de Performance Énergétique*"

<sup>3</sup>Décret n°2006-1147 du 14 septembre 2006 relatif au diagnostic de performance énergétique et à l'état de l'installation intérieure de gaz dans certains bâtiments.

<sup>4</sup>"*Bâtiment Basse Consommation*", BBC

energy efficiency. Recent studies, though they do not question it, tend to highlight the magnitude of underlying costs of energy retrofit investment, most of them being non financial, as opportunity cost, disturbance, or lack of information on actual potential retrofit for a full renovation (in the case of France for instance) but they are still to be precisely evaluated.

The goal of this paper is to analyze whether or not there is a price premium for green labeled housings. Price here refers to Willingness To Pay (WTP) on the sales market, as in [Brounen and Kok \(2011\)](#), [Fuerst et al. \(2015\)](#). In a desire to analyze households' behavior in terms of energy savings and emissions reductions, we use the mandatory CO2 emissions etiquette on French's EPC ranks to evaluate the comparative impacts between green labels for emissions and for consumption, as both scales might be far for each other: an electricity-heated housing consumes more, but is greener in terms of GHG emissions. We quantify this premium to analyze whether or not it is able to compensate the potential investment to be engaged by households to reach a green rank on the EPC scale. We refine our evaluation with each rank of the scale, and explore the problem of leaky homes.

## 2 Literature

There is a broad literature on consumer's interest for energy labels, mainly experimental, in which authors strive to show the interest people have in green labels. Nudges and social norms have emerged as a way to influence consumers, in various domains, and especially in their energy consumption ([Allcott \(2011\)](#)). Usually, policies consist in sending a consumption report that subtly compares them to their neighbors or their past consumption, following the idea they will "feel obliged to do better than the average". [Aroonruengsawat et al. \(2012\)](#) and [Holian \(2020\)](#) find a substantial decline in the residential energy consumption for buildings built after the implementation of a building codes policy. Most of the time, incentives seems to be playing with the reduction of misinformation about operating costs, transaction costs, and financial benefits of a given policy or behavior, as in [Fowlie et al. \(2015\)](#), who find evidence that encouraging households to follow a program, and more extensively guiding them in application processes helped improving subscription to the Weatherization Assistance Program.

On the housing market, these informative policies are likely to impact price levels. Hedonic approaches usually find a positive correlation between the "green housing" characterization and the price of the housing. [Brounen and Kok \(2011\)](#) is one of the first study to analyze green labels effect and finding a price premium of around 3.6 % relative to non-green labeled housings, the difference being explained by underlying energy consumption of the dwelling. Other studies in different housing markets are providing consistent results : [de Ayala et al. \(2016\)](#) finds a price premium between 5.4 % and 9.8 % for green housing on the Spanish market, all other characteristics equal, with estimated efficiency labels based on surveys. Of course, a variety of variables induce heterogeneity of the results: [Barreca et al. \(2021\)](#) emphasize on potential spatial effects over the impact

of energy attributes, while [Fuerst et al. \(2015\)](#) works on the type of dwelling, stating the price effect is stronger on flats and terraced dwellings rather than on semi detached and detached homes, with still a positive correlation. Overall, there seems to exist different sources at different levels of heterogeneity in the influence of energy labels over housing prices. So far, no study was performed in the French context.

Implications of a positive price premium on housings when renovating could be an incentive for households to renovate, considering that they would recover their investment not only under the form of an energy expenditure decline but also of cashback, in the case they do not occupy the dwelling long enough. Of course, this does not cover the whole investment mechanism, that probably includes reaction to intangible costs ([Rudinger and Gaspard \(2022\)](#), [Gillingham and Palmer \(2013\)](#), [Allcott and Rogers \(2014\)](#)).

Our article enriches the literature about green labels and price premium, in a study of French housing market at the household level, using two datasets and building a unique identifier. Studies in France over the impact of renovation on price are little, although public policies often emphasize the importance of a good renovation policy. We implement a new method to analyze for the detailed effect of each label, and analyze the impact of renovation council offices over the number of green dwellings.

## 3 Context and Data

### 3.1 Context of EPC ranks in France

Energy Performance Certificates<sup>5</sup> were first introduced in France in 2006, following the European Policy in terms of Greenhouse Gases emission limitations. They were made mandatory in 2007 for every dwelling destined to be sold or rented. The certificate initially is an information on the housing energy consumption based on the mean of the three last annual energy bills, the main drawback being it included people's consumption behavior. A new computation method was introduced in 2013 (3CL method for, translated from french, computation of the conventional consumption of dwellings) with the aim of increasing diagnoses reliability, and address the potential bias induced by household consumption. This new approach exclusively takes into account intrinsic characteristics of the housing: the heating type, the walls composition, insulation performance, heat losses across different surfaces, etc. Although aspects of the basic information remain unchanged for the consumer, the EPC reports gather other details and work suggestions with different cost-benefit ratios. An example from the French Ministry of Energy Transition is available in [Appendix A](#).

These informative measures were recently completed with restrictive incentives, with the French government planning to progressively phase-out the most energy intensive dwellings from the market, beginning with ranks F and G in 2028. Tenants might also require their landlord thermal

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<sup>5</sup>In French "Diagnostic de Performance Energétique"

improvements for leaky, non-decent dwellings. This may increase the importance of EPC notation in decision processes on housing markets in the future.

## 3.2 Data

### 3.2.1 Transaction and EPC data

In this study, we use the French record of Property values, an open source governmental database that gathers notarial acts that were filed for every French transaction apart from 2013. It includes basic information on each mutation, as the type of property and potential associated lots, their price and intrinsic characteristics such as precise geographic localization and address (coordinates, cadastre and full textual address), surface, land surface, number of rooms, date of build, etc. More specifically, the mutation price is the effective price paid by the buyer to the seller. It is relevant to mention in the event that EPC etiquettes are a bargaining point in the process of buying a house. Then, a part of difference between the announced price and the final transaction could also be explained by the EPC etiquette. Every mutation is identified at the date  $\times$  address level. Unfortunately, the key information of EPC notation does not figure in the data.

Therefore, I use another dataset provided by the French Agency for the Environment and Energy Management (ADEME) and Etalab<sup>6</sup>, that collects EPC diagnosis from early 2000's. In addition to the EPC rank, it contains the computation method, the estimated greenhouse gazes (GHG) emissions and its associated rank, a continuous variable for energy consumption, the precise address, coordinates, date and the reason for the diagnosis. EPC data are collected by government empowered professionals, that are the only ones being able to establish a diagnosis. The data is separated in two periods being before July 2021 and after July 2021. The data collection structure varies, as much more detailed information is available in the second phase of the database, including energy consumption with detailed information if more than one source is used, detailed heat loss by energy consumption items, and many more. Also, before July 2021, the energy consumption retained for the EPC computation gathered 3 items - general heating, hot water, cooling - whereas the new database includes 5 items: the three previous, lighting and auxiliaries. As a consequence, to compensate for the potential general rise of energy consumption, the frontiers of different ranks increased a bit, but unevenly. The details between old and new ranks can be found in Appendix B.

I match both datasets on the base of their textual address and geographic localization. Although EPC diagnosis are mandatory for housing transactions since 2007, having a housing in the EPC database does not guarantee to find it in the housing sells database. As a result, matching data drastically decreases the number of identified households. I assume that the match is correct for apartments, even though we do not have the very precise information of address (apartment number, etc.), for many reasons. First, a large majority is properly flagged as "Apartment" in the database,

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<sup>6</sup>Department of the French Inter-ministerial Digital Directorate

which allows for a late phase-out. Second, the fact that a diagnoses exists sharply increases the probability to find the corresponding transaction in the EPC database. Third, a good amount of buildings are homogeneous in terms of characteristics (central heating system, etc.) that has caused the EPC diagnosis to be centralized for buildings with less than 50 units, and usable for a transaction. If a housing is identified in both databases, I control for duplicate reports imposing a time window between two transactions at the same address and with the same file number<sup>7</sup>. This treatment still allows for multiple transactions for each dwelling. Each transaction is associated with the latest up to date EPC diagnosis. A dwelling might have different diagnosis, mainly if the sellers had performed energy retrofit works, or if the used EPC computation method has changed.

Three regions of mainland France are not represented in the transactions dataset due to legal specifications : Haut-Rhin, Bas-Rhin, and Moselle.

To account for potential reporting errors, or simply to eliminate outliers, I restrict the energy consumption values between the 0.01 and 0.99 percentiles. Beyond, not representative of the French housing stock. It allows the elimination. I am able to identify houses in every region, however it is not the case for every department, as can be seen on Figure 4 in Appendix C. From the [INSERER OBSERVATIONS] observations in the transactions dataset and the [INSERER OBSERVATIONS], we obtain a 830,413 unique observations database, that are distributed as in 1

**Table 1:** Distribution of unique addresses and transactions by dwelling type

	Apartments	Houses
<b>Unique addresses</b>	105,669	350,466
<b>Unique transactions</b>	436,472	393,941

Apartments seem to have a greater turnover than houses. In the same time, several apartments could be associated with an only address because of the lack of precision in coordinates and address. Table 2 represent descriptive statistics over the whole sample of the final merged dataset.

### 3.2.2 Spatial data

Intrinsic characteristics of dwellings should not be considered as the only ones able to explain for the transaction prices. Although a common way to take the dwelling’s localization into account when explaining its price is adding space fixed effects, which contribute refining the between spatial units estimation more than the estimation within a unit. In order to counter for these effects, I implement geographic attributes that aim to enrich my explanation of the price. The idea is that obviously some localization imply a higher price than other. In the same time, there would be a possibility that dwellings’ energy efficiency is not distributed randomly across mainland France:

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<sup>7</sup>Sometimes two transaction dates are separated by a few day or a month, which might correspond to market value estimation and transaction, or the agreement of price and the effective transaction date

**Table 2:** Descriptive statistics over the final merged table

	<b>Apartments</b>	<b>Houses</b>	<b>Total</b>
	436,472	393,941	830,413
<b>Transaction value</b>	178,385 (137,901)	228,560 (143,479)	202,188 (142,790)
<b>Gross floor area</b>	56.8 (48.9)	102.8 (146.5)	78.4 (108.9)
<i>Missing</i>	3,032	10,698	13,730
<b>Number of main rooms</b>	2.0 (1.5)	3.9 (1.7)	2.9 (1.9)
<b>Energy consumption</b>	227.5 (91.1)	238.9 (101.8)	232.8 (96.5)

**Note:** Values represent means over the corresponding type of housing. Between brackets are the associated standard deviations.

places where the housing market is dynamic or higher would not encourage energy retrofit works, as sellers would anticipate a rather low price devaluation caused by a bad score in efficiency. On the other way around places far from dynamic markets would encapsulate more green homes, being either build later in time with the expansion of urban areas, or renovated for other reasons than anticipated market competitiveness. Therefore, in average, the effect of greener EPCs would be underestimated. Thus, a challenge is to find a measure of spatial distribution of housing dynamics that is consistent across mainland France.

To do so, I use the French National Institute of Statistics and Economic Studies (INSEE) city catchment area zoning<sup>8</sup>. The zoning defines attraction poles that are built on population density and number of employments. A pole can correspond to one or several municipalities. Then, surrounding localities that send at least 15% of their active population are considered to be part of the ring municipalities, that are attracted by the pole. The zoning ranks different poles as a function of their attraction power and their population density. From my database point of view, it means that every city (and further every house) can be defined as part of an attraction pole. Attraction poles cannot overlap, and when two or more poles are concerned, the most dominant one is always preferred. As a consequence, I am able to cut the French territory into attraction areas. The distribution of observations and unique transactions across different types of catchment zone is given by Table 3

This measure has been introduced in 2020 by INSEE in replacement of 2010 and before urban areas.

<sup>8</sup>In French "Zonage en Aires d'Attraction des Villes"



**Table 3:** Number of observations and unique transaction of by catchment zone type

Type of municipality	Unique transactions
Central	326,404
Part of a main pole	228,165
Part of a secondary pole	6,452
Peripheral	239,144
Out of attraction areas	30,248
Total	<b>830,413</b>

**Note:** Additional explanations about what precisely are types of municipalities can be found in Appendix D

It is based on the national census of 2016 and the total number of inhabitants of each municipality of 2017. Although the criteria does not change, there are a proportion of municipalities that can be merged, especially between 2014 and 2019 according to INSEE. Their method is to allocate to a merged municipality in year  $n$  the category of year  $n$  to both initial municipalities for year  $n - 1$ . Corrected databases are all provided by INSEE. Although municipalities could change, the zones in themselves stay the ones that are defined in 2020. Thus, I have to assume that this definition is accepted for all the years I have available in my database, meaning 2013 to 2023. No other database provides thinner evolution in time. In the end, I attribute each observation an attraction zone depending on its municipality, using each year’s attraction database to avoid losing municipality names.

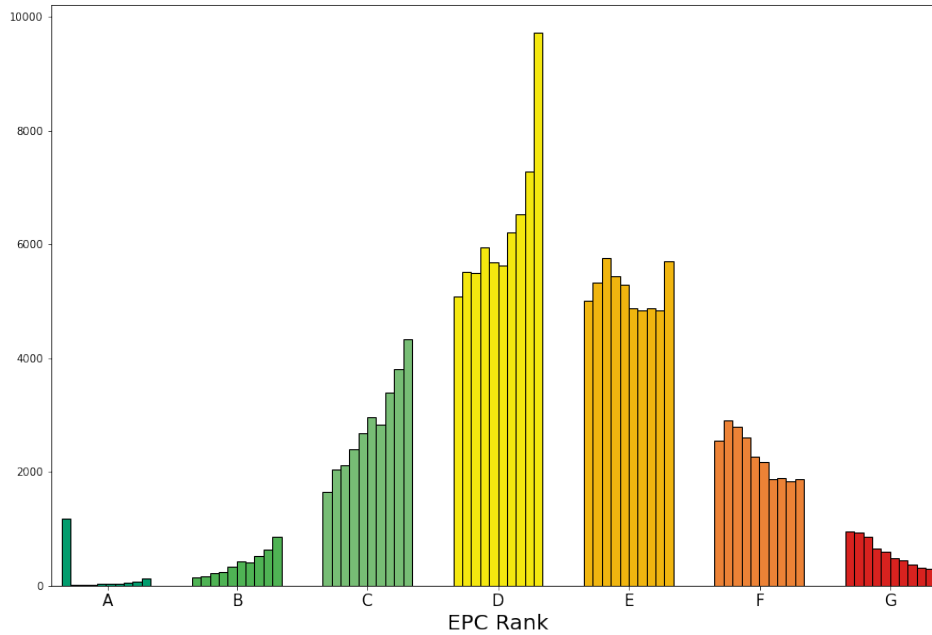
## 4 Set up

### 4.1 Dumping at EPC frontiers

Although the design of EPC ranks make it seem to be suitable for a regression discontinuity design, there is a concern about whether the data verifies the main assumptions, so that each treatment, being obtaining a letter compared to another, could be considered as as good as random around the different cutoffs, which correspond in our case to letters jumps. On Figure 1, it is clear that dwellings are distributed more frequently in the lower tail of each EPC rank.

One of the main important necessary assumption is that individuals, that is to say homeowners in our case, are unable to manipulate the treatment. In the case of EPC ranks design, there is a possibility that the sharp thresholds design can affect the verified distribution of energy efficiency. There already have been evidence in literature that people are able to manipulate their placement on EPC ranks. It has been the case in Ireland, that has a close definition of EPCs (see [Collins and Curtis \(2018\)](#)). They make a polynomial estimation of the counterfactual densities absent

**Figure 1:** Threshold effects in EPC distribution

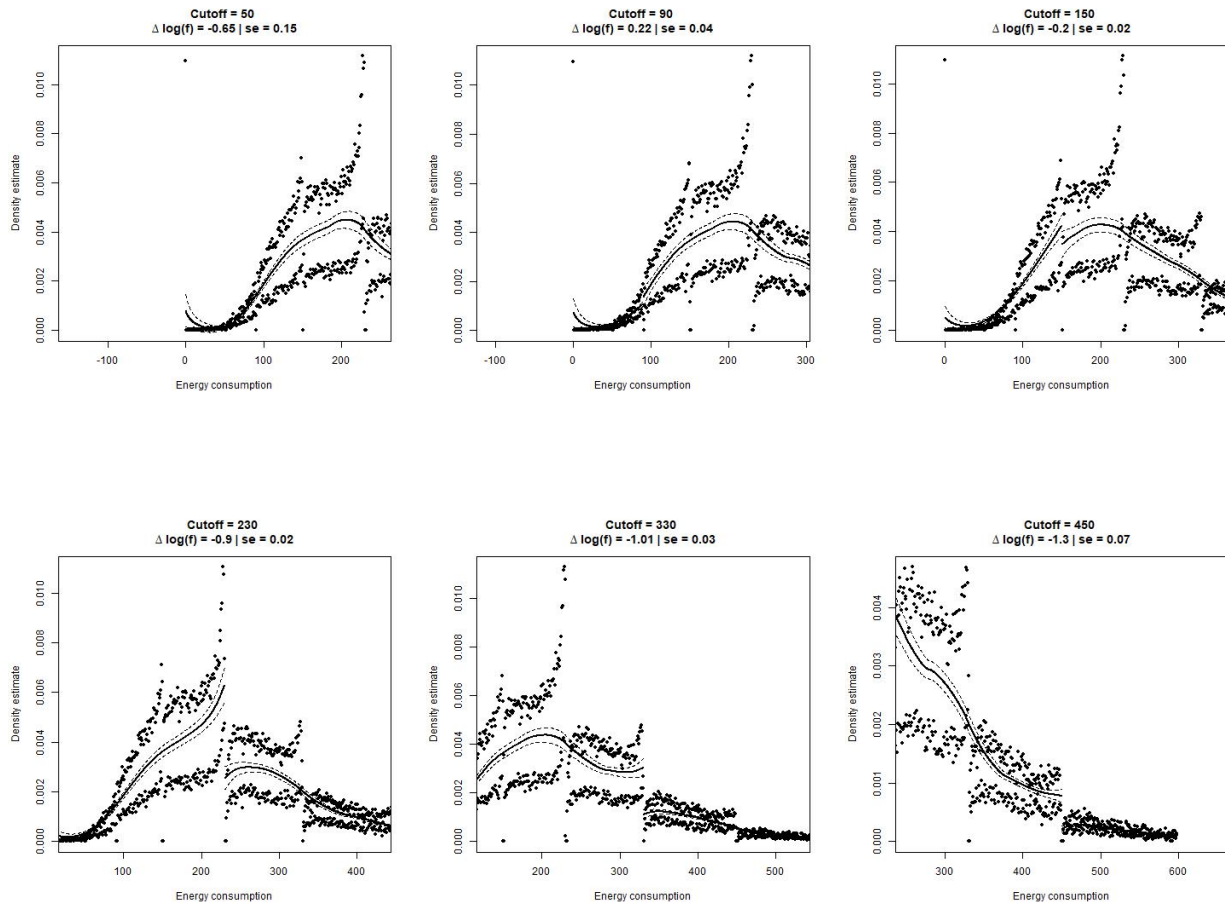


of the different cutoffs and measure the difference with histogram bins. Other methods exist to find evidence of discontinuities in the covariate. [McCrory \(2008\)](#) develops a test that analyses the difference between marginal densities around the threshold. Implementation of this test is simple and results can be found on [Figure 2](#).

Nearly all test statistics are significant at the 1% level. The most steep drops are for D-E, E-F and F-G jumps. However, we are not able yet to attribute these high discontinuities to the price premium found in the literature. One of the main reasons is that those sharp drops occur for ranks that are not green ranks, but are the most populated. It is plausible that rather than a price increase, people would only want to stay in the average consumption letters, more to deter someone not buying the house rather than attract someone buying it.

Mechanisms behind the manipulation of EPC ranks are unclear. Although it could be the result of EPC assessors empathizing with homeowners and adjusting a bit their rating to rank them in a superior class, [Collins and Curtis \(2018\)](#) finds no evidence that any assessor gives specifically better grades in Ireland. Also, he finds little correlation between a competitive environment for assessors and better EPC grades. However, although it is impossible to detect, there might be situations in which assessors would have an interest in giving better ranks. For example, a highly competitive market where goods are administrated by agencies could be a source of stable revenue for them if the agency and clients are satisfied with the assessor. Another idea is that it could be easy for

Figure 2: Density estimates of McCrary's test for each cutoff



**Note:** The test's null hypothesis is based on the log difference of the two estimated densities around the threshold.

homeowners to lie or manipulate some variables used in the computation of the EPC, whether it is voluntary or not. For example, the heating system play a high role, and two similar dwellings could have very different ratings, which may be independent of people’s will.

Bunching implies that regression discontinuity design is not the appropriate specification to guarantee identification of the EPC effect on housing price. We stay with the classical hedonic approach as in most of the papers relative to the subject (Brounen and Kok (2011); de Ayala et al. (2016); Barreca et al. (2021); Evangelista et al. (2020)). We use French cities’ attraction data to control for omitted variables on non-intrinsic factors that could affect the price.

## 4.2 Hedonic specification

Running a model that would encapsulate all the database may prove complicated. Indeed, the criteria for the attribution of given EPCs are unevenly distributed in time, before July 2021 and after July 2021. The transformation of threshold is, in addition, non linear, meaning that some may have their threshold conserved, some others may not. In a matter of consistency, I run each model on two separated datasets. I also distinguish between houses and apartments, trying to avoid the importance of a land associated with a transaction. On each model that I run, I than have a set of 4 vectors of coefficients that express EPC’s impact on the housing price.

We adopt the following general specification:

$$\log P_i = \beta_0 + \beta_1 \text{EPC}_i + \beta_2 C_i + \lambda X_i + \mu S_i + \gamma_i + \zeta_t + \epsilon_i \quad (1)$$

Where  $\log P_i$  is the logarithmic transformation of the housing price, and  $\text{EPC}_i$  and  $C_i$  are respectively the EPC label and the continuous variable that estimates houses’ energy consumption. Vector  $X_i$  is a set of control variables which are intrinsic characteristics of the dwellings (Surface, surface of the associated land, number of main rooms, age and type of residential structure, etc.). Vector  $S_i$  encapsulate several characteristics relative to the environment of the dwelling, mainly inherited from the attraction zones dataset (the type of city it is situated in relative to the nearest attraction pole, the metric distance to the nearest attraction pole, the type of attraction, the urban or rural characteristic, etc.). Vectors  $\gamma_i$  and  $\zeta_t$  account respectively for postcode and time fixed effects. I further test for the metric distance from the house  $i$  to the city center in the vector  $S_i$  (measured by city halls), trying to better explain variance of the price within any fixed effects. The point of the attraction zones approach is to have a good and consistent measure of dynamism and attractiveness for the whole country.

## 5 Main results

### 5.1 First specification

The results of the first specification are presented in Table 4, with the data limited to Houses for the first column and apartments for the second column. In the following, every percentage value given is obtained by  $\exp(\beta) - 1$ ,  $\beta$  being the studied coefficient in the regression table 4. Several characteristics of dwellings have a positive and significant impact on the price. For both houses and apartments, the more recent, the higher the price. However, there seems to be a "vintage premium", with old houses and apartments having a positive and significant impact, higher for dwellings built in between old and new times. Also, an additional room increases the price by 22% for an apartment and 10% for a house, the main reason being that the average house has two times more rooms (see Table 2). The same way, we find that an additional square meter increases the price by 1.2% for a house and 2.1% for an apartment, with similar reasons than for the number of main rooms. Then, the distance to the city center, that is in reality approximated by the distance between a given dwelling and the city-hall associated with the municipality, has a negative impact on the price for houses, and positive and significant for apartments. My guess on the sign is that apartments near the city center might be smaller and as a consequence lower in price. Further, we will study heterogeneity in the results limiting the database to cities of different classes.

I express EPC price premium relative to class D, which is the most populated class. Note that I dropped rank A from the database as its under-representation biased down results. Gathering ranks A and B also includes this bias. The fixed effects approach allow for a relatively good  $R^2$  at the general level. However, I obtain a pretty low value for the within  $R^2$ , meaning that I am unable to explain a lot of the variance for a given postcode. Having a good explanation power in this situation is important because it acts as the direct reflect of ability of the data to correctly explain the price of dwellings. I find a positive and significant impact for better EPcs than the average (ranks B and C). For example, a rank B dwelling is valued 8% more than a rank D dwelling. For ranks B and C, premiums are pretty consistent between houses and apartments. In the case of low-efficiency buildings, we find that coefficients for houses are strictly negative and all significant. A rank G house is 6% less expensive than an equivalent rank D house. There is a large jump in the effect that nearly doubles between rank E and F, but the difference between ranks F and G does not stand out. Interestingly, the devaluation is lower than the premium in magnitude, which could suggest that low-efficiency houses main still have market value due to potential other factors. In the case of apartments, the devaluation smaller in magnitude, but negative and significant for ranks E and F, but is not found statistically different from 0 for rank G. Also, the devaluation is way smaller than for houses. This could come from the fact that a good majority of apartments may benefit from collective heating, causing people to have a fixed amount of charges to pay every month, no matter what. Buyers and in-occupants may then have their awareness of energy efficiency lowered, as collective charges vary a lot between co-ownerships, whether it is monitored by an agency or

**Table 4:** Results for the first specification, data before July 2021

<i>Dependent variable:</i>	$\ln P$	
	(1) <b>Houses</b>	(2) <b>Apartments</b>
<b>EPC</b>		
B	0.0837*** (0.0081)	0.0873*** (0.0135)
C	0.0488*** (0.0042)	0.0466*** (0.0072)
D	-	-
E	-0.0333*** (0.0040)	-0.0162** (0.0063)
F	-0.0603*** (0.0077)	-0.0292** (0.0123)
G	-0.0638*** (0.0132)	-0.0003 (0.0211)
<b>Estimated energy consumption</b>	-0.0006*** ( $4.59 \times 10^{-5}$ )	-0.0003*** ( $6.53 \times 10^{-5}$ )
<b>Gross surface</b>	0.0012*** (0.0004)	0.0021*** (0.0007)
<b># Main rooms</b>	0.1095*** (0.0059)	0.2028*** (0.0128)
<b>Distance to center</b>	$-3.43 \times 10^{-6}$ ( $6.25 \times 10^{-6}$ )	0.0006*** ( $2.68 \times 10^{-5}$ )
<b>Date of built</b>		
Before 1900	0.2023** (0.0795)	0.1224*** (0.0223)
1900-1950	0.1810** (0.0801)	-0.0132 (0.0162)
1950-1970	0.1915** (0.0802)	-0.1014*** (0.0171)
1970-1990	0.2340*** (0.0803)	-0.0130 (0.0154)
1990-2000	0.2996*** (0.0804)	0.0872*** (0.0176)
2000-2010	0.3149*** (0.0805)	0.1660*** (0.0175)
2010-2021	0.3484*** (0.0811)	0.1840*** (0.0205)
<b>Property age</b>	$-3.22 \times 10^{-5}$ ( $2.59 \times 10^{-5}$ )	$-1.58 \times 10^{-5}$ *** ( $5.35 \times 10^{-6}$ )
<i>Fixed-effects</i>		
Postcode	Yes	Yes
Transaction year	Yes	Yes
<i>Fit statistics</i>		
Observations	241,162	291,093
R <sup>2</sup>	0.63066	0.48489
Within R <sup>2</sup>	0.29445	0.29045

*Clustered (Postcode) standard-errors in parentheses*  
*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*

not, a syndicate, etc. Bargaining power is also very low for owners in terms of general life of the building. Added to the fact that collective EPC reports (for the building) could before July 2021 be used solely in the sake of selling, the invisible proportion of the charges dedicated to energy may overcome the visual effect of EPCs. Also, some reasoning could be done in terms of general inertia of the building, in the hope of benefiting from neighbors heating. Eventually, apartments could be situated more frequently in tensed markets, which in addition to all other arguments, may explain why care for good efficiency may not be valued anymore when buying.

The estimation of energy consumption also has its importance. In Appendix F are the same table in the case I do not include this continuous measure of estimated energy consumption of the dwelling. This variable depends on a lot of factors in the case of EPC report establishment. Some of them may depend on anterior bills, some of them may be more liable estimations. As consumption is located at the bottom of ranks for the most, it might capture in-rank variations. It is still coherent with the notion of "visual effect", as estimated primary energy consumption and estimated bills are available on the EPC report.

## 6 Results' consistency

### 6.1 Influence of market dynamics

A concern that may arise with the potential influence of market dynamics that may overcome the potential influence of EPC ranks on the housing price. Housing market can be influenced locally by many factors. Although we cannot take all of them into account, I argue that my analysis may have to be refined depending on those local housing markets, that I define following the city catchment area zones. In the span of the five types of attraction, that account for five different structures and intensities. I choose to run a fixed effects regression on each of them, with a separation between houses and apartments once again. All regression tables will be available below, but I choose to only represent effects of EPC ranks on the price. Effects are expressed in percentages, with the baseline rank still being rank D. Other variables relative to the zone I am looking at are expressed, that mainly ranks them into sizes. Attraction zones can be detailed by poles and peripheral zones of different sizes. Size categories are provided by INSEE, by inhabitants: less than 50,000, between 50,000 and 200,000, between 200,000 and 700,000, more than 700,000.

I present in Table 5 the coefficients corresponding to the variable  $EPC_i$  in the first specification (1). For the sake of simplicity and place, I only put show these coefficients, there magnitude might increase or decrease in favor of others. The effect of EPC ranks with respect to different scales of dynamism is relatively mitigated. First, it is noticeable that the different effects are more frequently significant for houses than for apartments. Of course, the number of available observations highly depends on the geographical context and organization. It could suggest that apartments are in average more sensitive to market dynamics than houses, potentially due to the highest turnover

**Table 5:** Effects on price on different housing markets**(a)** Effect of EPC ranks on housing price, for houses

	Less than 50,000		Between 50,000 and 200,000		Between 200,000 and 700,000		More than 700,000	
	<i>Pole</i>	<i>Periphery</i>	<i>Pole</i>	<i>Periphery</i>	<i>Pole</i>	<i>Periphery</i>	<i>Pole</i>	<i>Periphery</i>
<b>B</b>	0.102***	0.0234	0.1402***	0.1353***	0.0509*	0.0922***	0.0689***	0.0617***
<b>C</b>	0.064***	0.0456***	0.0801***	0.0806***	0.0499***	0.0384***	0.0332***	0.0317***
<b>E</b>	-0.0461***	-0.0423**	-0.0508***	-0.0653***	-0.0386***	-0.04***	-0.0054	-0.0183**
<b>F</b>	-0.0741**	-0.087***	-0.0921***	-0.1206***	-0.073***	-0.0722***	-0.0056	-0.0212
<b>G</b>	-0.0381	-0.014	-0.1075***	-0.1572***	-0.0462	-0.0976***	-0.0208	-0.0506*
<b>N obs</b>	9,824	1,435	27,553	3,974	67,850	9,652	156,242	14,563

**(b)** Effect of EPC ranks on housing price for apartments

	Less than 50,000		Between 50,000 and 200,000		Between 200,000 and 700,000		More than 700,000	
	<i>Pole</i>	<i>Periphery</i>	<i>Pole</i>	<i>Periphery</i>	<i>Pole</i>	<i>Periphery</i>	<i>Pole</i>	<i>Periphery</i>
<b>B</b>	0.0737	0.2578*	0.1174*	0.0928	0.0655**	0.0731	0.0898***	-0.0324
<b>C</b>	0.0441	0.0858	0.0467**	0.0474	0.0277*	0.0369	0.0537***	-0.0016
<b>E</b>	-0.0176	0.0115	9e-04	-0.0502	-0.0105	-0.0277	-0.02**	4e-04
<b>F</b>	0.0253	-0.2061	-0.0376	0.0128	-0.0364	-0.0264	-0.036**	0.0556
<b>G</b>	0.0194	-0.1592	0.0117	0.067	0.0305	0.0488	-0.0195	0.0258
<b>N obs</b>	15,467	11,240	25,088	30,543	29,009	36,752	52,127	40,936



on the market. Then, other factors could be more influential on the price, such as the precise localization, that we are not able to take into account in this study. In both cases, houses and apartments, the "green effect" (that is the effect of having a top rank dwelling relative to mid rank) seems to be higher in magnitude in smaller poles and peripheries than for bigger ones, suggesting that value attributed to EPC is higher in non dynamic markets.

In another approach, in Table 6, I gather the most probable dynamic housing markets in France, and compare it to the initial analysis of Table 4. To do so, I restrict the database to cities which main pole is among Paris, Lyon, Marseille, Nantes, Strasbourg, Lille and Bordeaux. For example, cities which main pole is Lyon are all cities attached to Lyon, that is to say Lyon itself, the suburbs, and other cities near Lyon that send 15% at least of workers every day. To try to capture heterogeneity, I still control for the distance to city center. I find that the green premium for houses seems to decrease relative to the aggregated version on France for ranks B and C. Although rank below D are not significant, their magnitude is also lower. This is consistent with the previous results by pole and periphery sizes. In the case of apartments, the results quite differ: not only the premium for ranks B and C is higher, but the devaluation is also greater and significant for ranks E and F. It is surprising considering that it could be anticipated that the premium and devaluation would be lower in percentage in dynamic markets, where the average per meters squared price is higher in average. Although I struggle finding significance for some labels and having a high within  $R^2$ , it may signify that on average buyers tend to value EPC ranks in major cities, maybe as they can be a discriminant negotiation point in tight markets. Of course, I do not exclude the fact that the effect could be biased towards larger magnitudes due to unobserved attributes. It is hard to infer that the difference would come from buyers' behaviors and beliefs, that would be heterogeneous between major cities and other ones, because I cannot find the same effects on houses.

## 6.2 Time consistency

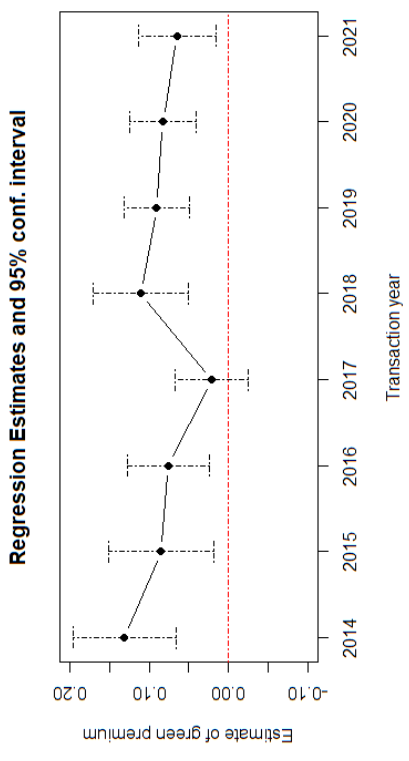
Looking at the evolution of trends in price of my dataset provides the same insights as what is well known in France for the period 2014 - 2021, which is an increase of average price (see 5 in Appendix G). I look at the coefficient estimates of a postcode-fixed-effects regression very similar to the first specification to see whether different growing rates in different EPC ranks can be attributed to the EPC.

Yearly effects are mostly consistent in the case of green premiums (that is to say the coefficient attributed to rank B of the EPC), and the effect stays pretty consistent over the observed period, for both houses and apartments. In the case of devaluation, which is the coefficient attributed to rank G of the EPC, it is unclear how it behaves. In the case of houses, it is negative and significantly different from zero most of the time, and positive and insignificantly different from zero which decreases the credibility of the coefficient at this particular date. Surprisingly however, the devaluation coefficient is positive at several dates in the case of apartments. This potentially suggest that, once again, apartments are way more sensible to market dynamics, or simply other

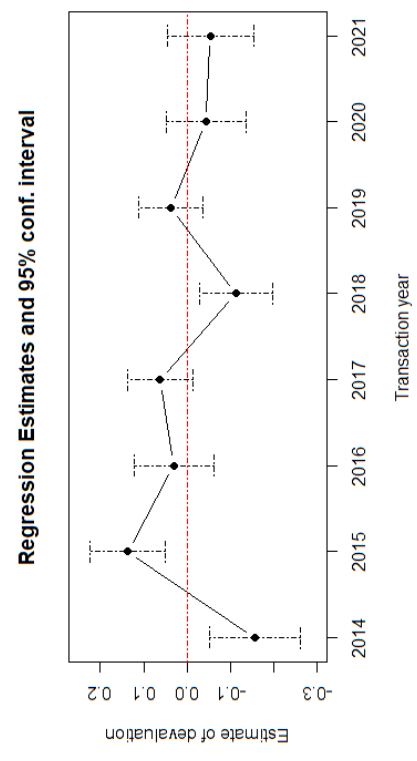
**Table 6:** Regression table for model (1) and most dynamic markets

<i>Dependent variable:</i>	$\ln P$	
	(1) Houses	(2) Apartments
<b>EPC</b>		
B	0.0561*** (0.0134)	0.0977*** (0.0202)
C	0.0278*** (0.0064)	0.0539*** (0.0118)
E	-0.0102 (0.0068)	-0.0226** (0.0088)
F	-0.0110 (0.0130)	-0.0436** (0.0180)
G	-0.0328 (0.0223)	-0.0193 (0.0319)
<b>Energy consumption</b>	-0.0004*** ( $6.77 \times 10^{-5}$ )	-0.0002* ( $9.73 \times 10^{-5}$ )
<b>Gross surface</b>	0.0028*** (0.0004)	0.0024*** (0.0007)
<b># Main rooms</b>	0.0854*** (0.0073)	0.2136*** (0.0160)
<b>Distance to center</b>	$-3.7 \times 10^{-5}$ *** ( $3.83 \times 10^{-6}$ )	-0.1257** (0.0515)
<b>Date of build</b>		
Before 1900	0.3064 (0.2221)	0.0532** (0.0244)
1900-1950	0.2935 (0.2292)	-0.0350* (0.0184)
1950-1970	0.3312 (0.2306)	-0.1030*** (0.0196)
1970-1990	0.3408 (0.2326)	-0.0159 (0.0161)
1990-2000	0.3817 (0.2344)	0.1005*** (0.0202)
2000-2010	0.3836 (0.2360)	0.1826*** (0.0181)
2010-2021	0.3808 (0.2364)	0.1308*** (0.0238)
<b>Property age</b>	0.0001 (0.0001)	$-1.2 \times 10^{-5}$ *** ( $4.1 \times 10^{-6}$ )
<i>Fixed-effects</i>		
Postcode	Yes	Yes
Transaction year	Yes	Yes
<i>Fit statistics</i>		
Observations	77,221	127,741
R <sup>2</sup>	0.58898	0.41096
Within R <sup>2</sup>	0.32015	0.30163

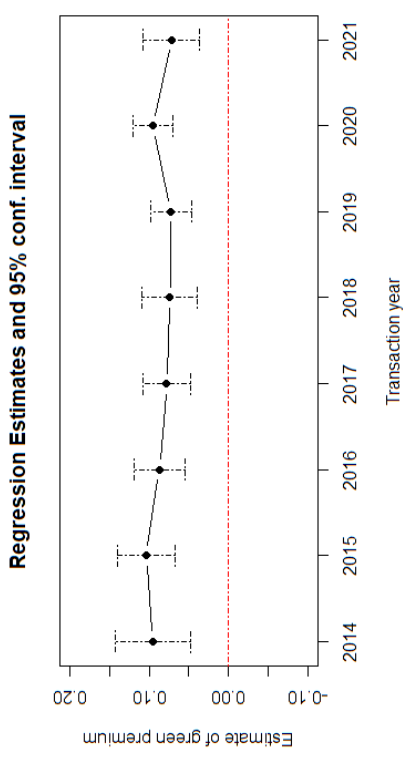
*Clustered (CP) standard-errors in parentheses*  
*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*



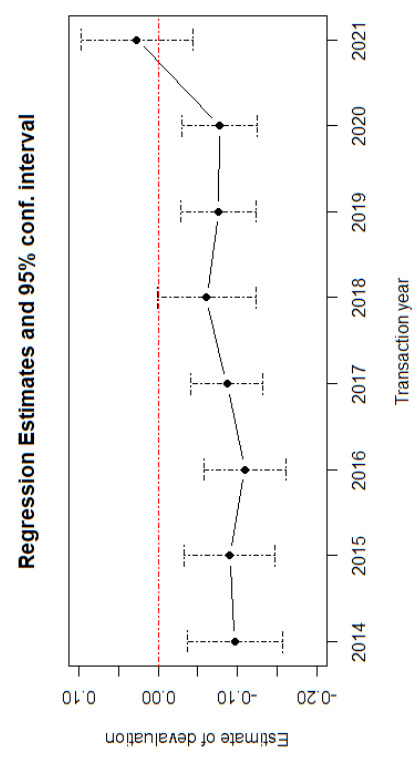
(a) Green premium for houses



(b) Green premium for apartments



(c) Devaluation for houses



(d) Devaluation for apartments

Figure 3: Time consistency

price drivers than the EPC. Additionally, there is a probable direct relationship with the rental market way stronger than in the case of homes, due to the most frequent localization near city centers or near suburbs, where households may either be more tempted to invest for the pure sake of renting, or either have inherited. As a consequence, low efficiency apartments may suffer less from potential devaluation attributed to efficiency rating, because of their number on the market, and a tense market. This could encourage future research to focus on effects on well defined shocks on the rental market, to see how it impacts the price of housing. For example, one could imagine that the announcement of the climate and resilience act<sup>9</sup>, that will further ban the rental of F and G dwellings, had an impact and will have an impact on sells approaching the deadline. Owners may want to sell to get cash rather than engaging costly renovation work to get to a superior rating, that may eventually be obsolete in several years. In the same time, buyers and renters may be aware of such interdiction and use the EPC rank as a bargaining tool. It is then likely that the devaluation becomes higher both by bargaining and massive supply of dwellings.

Although I mainly perform my analysis over a set of transactions occurring before 2021, in Appendix H, I show the results for the first specification (1) in the case of after July 2021 transactions. As said in 4.2, the thresholds for the attribution of the EPC are not the same between the two database, which is obviously a problem for having a good estimation strategy. Still, I find that devaluation becomes negative and significantly different from 0 for both houses and simply negative for apartments from July 2021. Once again, this conveys the idea that I may fail to capture hidden mechanisms on the housing market specifically looking at efficiency ratings.

## 7 Conclusion

Efficiency ratings are particularly important in the context of reducing global emissions, for many reasons. If measured correctly, their capitalization on the housing market captures buyers willingness to pay for energy efficiency. For sellers and more generally homeowners, it also reflects how can an energy renovation still be (or not be) beneficial for their wallet. As the average occupying duration is around 10 years in France, people that invest in a full and efficient energy renovation might not have the time to recover from their investment. Selling at a higher price is obviously the best way to ensure the profitability of their investment (if they care for it of course).

In this paper, I try to estimate the capitalization of EPC rank on the French housing market, using national data and a standard hedonic estimation strategy. Although I refine the result by a measure of local dynamism to account for market dynamics, I find both intuitive and counter intuitive results on how different labels explain the price of a given dwelling. More specifically, if the green premium is always positive and significantly different from 0, the devaluation caused by being part of the G rank is still unclear. Of course, I might lack of explaining power in my different regressions, because

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<sup>9</sup><https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000043956924>

I want to keep data at the national level and not take a set of cities as examples. The average green premium for houses (rank B with respect to rank D) is around 8% for both apartment and houses. However, the devaluation is stronger for houses: rank G houses are in average 6% less expensive than rank D dwellings, whereas the effect is quasi non-existent for apartments. Being in a more dynamic area seem to decrease the relative effects for premium and devaluation, meaning the price is nearer the price of rank D dwelling in percentage points, especially for houses. Of course, the absolute value may stay high. In the case of apartments, results are less intuitive and less clear: being in an important city center seem to increase percentage points for green premiums, suggesting that market dynamics may overcome the effect attributed to energy efficiency. Devaluation estimates are the harder to interpret, because I often lack significance, especially for apartments. My main explanation is once again that market dynamics, that may be influenced by French policies as the climate and resilience act, are less intuitive than expected, with for instance, in the case of low efficiency apartment, a strong bond with the rental market that may require a deeper structural analysis.

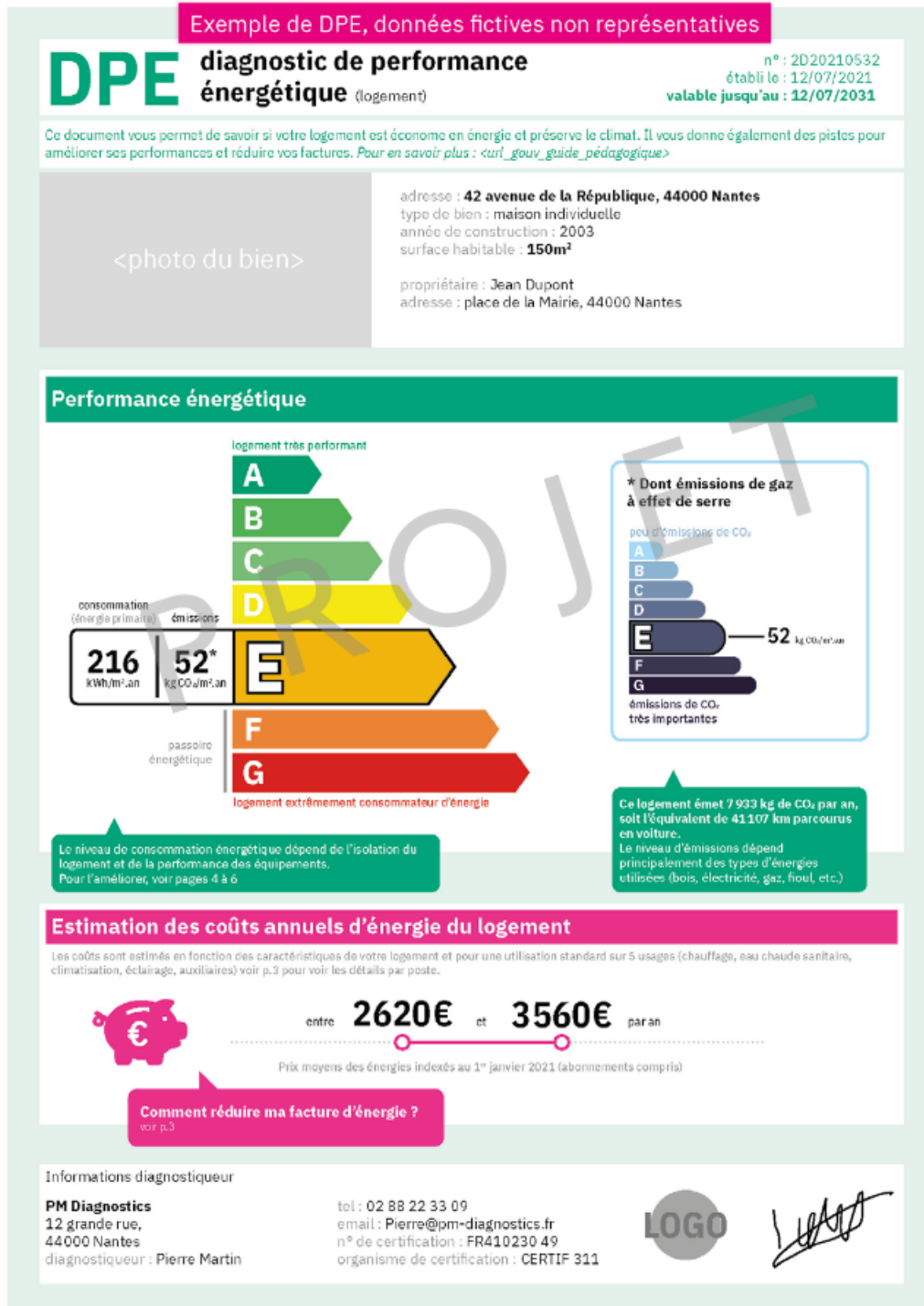
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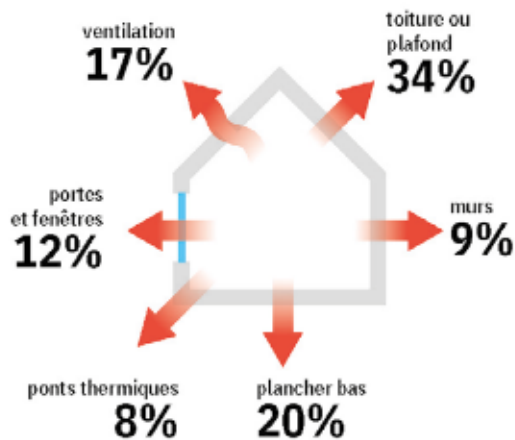
# Appendix

## A EPC diagnosis example





### Schéma des déperditions de chaleur



### Performance de l'isolation



INSUFFISANTE MOYENNE BONNE TRÈS BONNE

### Système de ventilation en place



Ventilation mécanique contrôlée simple flux autoréglable.

### Confort d'été (hors climatisation)\*



Les caractéristiques de votre logement améliorant le confort d'été :



bonne inertie du logement



logement traversant

Pour améliorer le confort d'été :



Équipez les fenêtres de votre logement de volets extérieurs ou brise-soleil.



Faites isoler la toiture du bâtiment (rapprochez-vous de votre copropriété).

### Production d'énergies renouvelables

Ce logement n'est pas encore équipé de systèmes de production d'énergie renouvelable.

Diverses solutions existent :



pompe à chaleur



chauffe-eau thermodynamique



panneaux solaires photovoltaïques



panneaux solaires thermiques



géothermie



réseaux de chaleur vertueux



chauffage au bois

\*Le niveau de confort d'été présenté ici s'appuie uniquement sur les caractéristiques de votre logement (la localisation n'est pas prise en compte).

Montants et consommations annuels d'énergie

usage		consommation d'énergie (en kWh énergie primaire)	frais annuels d'énergie (fourchette d'estimation*)	répartition des dépenses
chauffage	fioul	22 500 (22 500 é.f.)	entre 1740€ et 2370€	67%
eau chaude sanitaire	électrique	8 625 (3 750 é.f.)	entre 750€ et 1030€	29%
refroidissement		0 (0 é.f.)	0€	0%
éclairage	électrique	690 (300 é.f.)	entre 60€ et 90€	2%
auxiliaires	électrique	690 (300 é.f.)	entre 60€ et 90€	2%
énergie totale pour les usages recensés :		32 505 kWh (26 850 kWh é.f.)	entre 2620€ et 3560€ par an	

Pour rester dans cette fourchette d'estimation, voir les recommandations d'usage ci-dessous

Ces chiffres sont donnés pour une température de chauffage de 19°, une climatisation réglée à 28° (si présence de clim), et une consommation d'eau chaude de 123ℓ par jour.

▲ Seules les consommations d'énergie nécessaires au chauffage, à la climatisation, à la production d'eau chaude sanitaire, à l'éclairage et aux auxiliaires (ventilateurs, pompes) sont prises en compte dans cette estimation. Les consommations liées aux autres usages (électroménager, appareils électroniques...) ne sont pas comptabilisées.

▲ Les factures réelles dépendront de nombreux facteurs : prix des énergies, météo de l'année (hiver froid ou doux...), nombre de personnes dans le logement et habitudes de vie, entretien des équipements...

é.f. → énergie finale

\* Prix moyens des énergies indexés au 1<sup>er</sup> janvier 2021 (abonnements compris)

Recommandations d'usage pour votre logement

Quelques gestes simples pour maîtriser votre facture d'énergie :



Température recommandée en hiver → 19°

Chauffer à 19° plutôt que 21°, c'est -15% sur votre facture **soit -308€ par an**

astuces

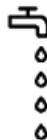
- Diminuez le chauffage quand vous n'êtes pas là.
- Chauffez les chambres à 17° la nuit.



Si climatisation, température recommandée en été → 28°

astuces

- Fermez les fenêtres et volets la journée quand il fait chaud.
- Aérez votre logement la nuit.



Consommation recommandée → 132ℓ/jour d'eau chaude à 40°

Estimation faite par rapport à la surface de votre logement (2-3 personnes). Une douche de 5 minute = environ 40ℓ.

54ℓ consommés en moins par jour, c'est -29% sur votre facture **soit -365€ par an**

astuces





- Installez des mousseurs d'eau sur les robinets et un pommeau à faible débit sur la douche.
- Réduisez la durée des douches.



En savoir plus sur les bons réflexes d'économie d'énergie : [www.faire.gouv.fr/reduire-ses-factures-energie](http://www.faire.gouv.fr/reduire-ses-factures-energie)

Voir en annexe le descriptif complet et détaillé du logement et de ses équipements

### Vue d'ensemble du logement

	description	isolation
 murs	<b>Murs nord, ouest, sud</b> en blocs de béton pleins donnant sur l'extérieur, avec isolation intérieure. <b>Mur est</b> en blocs de béton creux donnant sur un garage, non isolé.	<b>bonne</b>
 plancher bas	Plancher lourd type, entrevous terre-cuite, poutrelles béton donnant sur vide sanitaire, isolation inconnue.	<b>insuffisante</b>
 toiture/plafond	Combles aménagés sous rampant donnant sur l'extérieur, isolé.	<b>insuffisante</b>
 portes et fenêtres	Porte bois opaque pleine. Fenêtres battantes PVC, double vitrage et volets roulants PVC. Portes-fenêtres battantes avec soubassement PVC, double vitrage et volets roulants PVC.	<b>moyenne</b>

### Vue d'ensemble des équipements

	description
 chauffage	Chaudière fioul standard installée entre 1991 et 2015 (système individuel). ▲ Cheminée à foyer ouvert : son utilisation, même occasionnelle, est source de gaspillage énergétique et présente de forts impacts sur la qualité de l'air.
 eau chaude sanitaire	Ballon électrique à accumulation vertical, avec ballon séparé (système individuel).
 climatisation	Sans objet
 ventilation	VMC simple flux autoréglable installée avant 1982.

### Recommandations de gestion et d'entretien des équipements

Pour maîtriser vos consommations d'énergie, la bonne gestion et l'entretien régulier des équipements de votre logement sont essentiels.

	type d'entretien
 VMC	Nettoyer les bouches d'aération → 1 fois par an changer les filtres → tous les 2 ans
 chaudière	Entretien par un professionnel → 1 fois par an.
 radiateurs	Nettoyer les radiateurs régulièrement pour garder leur efficacité.
 éclairages	Description
 vitrages	Pour garder un logement lumineux penser à nettoyer les vitres régulièrement.
 circuit de chauffage	Description
 climatiseur	Description

▲ Selon la configuration, certaines recommandations relèvent de la copropriété ou du gestionnaire de l'immeuble.

Recommandations d'amélioration de la performance énergétique



Des travaux peuvent vous permettre d'améliorer significativement l'efficacité énergétique de votre logement et ainsi de faire des économies d'énergie, d'améliorer son confort, de le valoriser et de le rendre plus écologique. Le pack 1 de travaux vous permet de réaliser les travaux prioritaires, et le pack 2 d'aller vers un logement très performant.



Si vous en avez la possibilité, il est plus efficace et rentable de procéder à une rénovation globale de votre logement (voir packs de travaux 1+2 ci-dessous). La rénovation performante par étapes est aussi une alternative possible (réalisation du pack 1 avant le pack 2). Faites-vous accompagner par un professionnel compétent (bureau d'études, architecte, entreprise générale de travaux, groupement d'artisans...) pour préciser votre projet et coordonner vos travaux.

**1 Les travaux essentiels** montant estimé : 9000 à 12000€

lot	description	performance recommandée
toiture et combles	Isoler les combles.	R = 4,5 m <sup>2</sup> .K/W
chauffage	Installer une pompe à chaleur.	<chiffre_perf.>
portes et fenêtres	Refaire l'étanchéité des huisseries.	<chiffre_perf.>

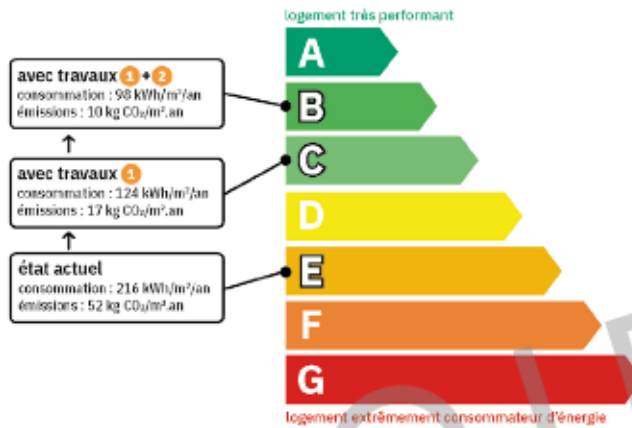
**2 Les travaux à envisager** montant estimé : 20000 à 25000€

lot	description	performance recommandée
murs	Isolation des murs par l'extérieur. Si un ravalement de façade est prévu, effectuez une isolation par l'extérieur avec des retours d'isolants au niveau des tableaux de baie. ▲ travaux pouvant nécessiter une autorisation d'urbanisme ▲ travaux à réaliser par la copropriété	R = 4,5 m <sup>2</sup> .K/W
plancher bas	Isolation du plancher bas en sous-face.	<chiffre_perf.>
eau chaude sanitaire	Changer le chauffe-eau.	<chiffre_perf.>
ventilation	Installer une VMC hydroréglable type B.	<chiffre_perf.>

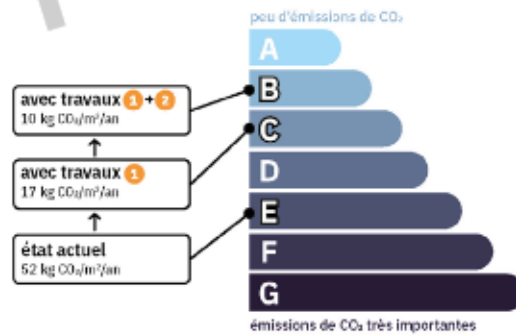
Commentaires :

Recommandations d'amélioration de la performance énergétique (suite)

Évolution de la performance énergétique après travaux



Dont émissions de gaz à effet de serre



Préparez votre projet !

Contactez le conseiller FAIRE le plus proche de chez vous, pour des conseils gratuits et indépendants sur vos choix de travaux et d'artisans : [www.faire.gouv.fr/trouver-un-conseiller](http://www.faire.gouv.fr/trouver-un-conseiller) ou 0808 800 700 (prix d'un appel local)

Vous pouvez bénéficier d'aides, de primes et de subventions pour vos travaux : [www.faire.gouv.fr/aides-de-financement](http://www.faire.gouv.fr/aides-de-financement)



Pour répondre à l'urgence climatique et environnementale, la France s'est fixée pour objectif d'ici 2050 de rénover l'ensemble des logements à un haut niveau de performance énergétique.

À court terme, la priorité est donnée à la suppression des énergies fortement émettrices de gaz à effet de serre (fioul, charbon) et à l'éradication des « passoires énergétiques » (obligation de travaux avant 2028).

## Fiche technique du logement

Cette fiche liste les caractéristiques techniques du bien diagnostiqué renseignées par le diagnostiqueur pour obtenir les résultats présentés dans ce document. En cas de problème, contactez la personne ayant réalisé ce document ou l'organisme certificateur qui l'a certifiée (diagnostiqueurs.din.developpement-durable.gouv.fr).

Référence du logiciel validé : LILICIEL Diagnostics v4

Référence du DPE : 2D20210532

Invariant fiscal du logement : 1234567890

Référence de la parcelle cadastrale : 000AN0055

Méthode de calcul utilisée pour l'établissement du DPE : 3CL-DPE 2021

Numéro d'immatriculation de la copropriété : TC6670042

Justificatifs fournis pour établir le DPE :

→ Fiche technique de chaudière,

→ Facture de travaux d'isolation

Rapport d'entretien ou d'inspection de la chaudière joint

## généralités





donnée d'entrée	origine de la donnée	valeur renseignée
département		44000
altitude	données en ligne	123m
type de bien	observé	maison individuelle
année de construction	document fourni	1878
surface habitable	mesuré	140m <sup>2</sup>
nombre de niveaux	observé	2
hauteur moyenne sous plafond	mesuré	3m
nb. de logements du bâtiment	observé	1

## enveloppe

murs	mesuré	→ Mur couble avec lame d'air non isolé donnant sur l'extérieur Surface : 18 m <sup>2</sup> , Donnant sur : l'extérieur, U : 2 W/m <sup>2</sup> /°C, b : 1
	mesuré	→ Mur couble avec lame d'air non isolé donnant sur un local tertiaire Surface : 22 m <sup>2</sup> , Donnant sur un local tertiaire, U : 2 W/m <sup>2</sup> /°C, b : 0,2
	mesuré	→ Mur couble avec lame d'air non isolé donnant sur des circulation communes avec couche ou gaine de désenfumage, ouverte en permanence
	mesuré	→ Surface : 26 m <sup>2</sup> , Donnant sur : des circulation communes avec bouche ou gaine de désenfumage, ouverte en permanence, U : 2 W/m <sup>2</sup> /°C, b : 0,35
plancher bas	mesuré	→ Dalle béton non isolé donnant sur un local chauffé Surface : 80 m <sup>2</sup> , Donnant sur : un local chauffé, U : 2 W/m <sup>2</sup> /°C, b : 0
toiture/plafonds	par défaut	→ valeur par défaut U : 2 W/m <sup>2</sup> /°C, b : 0
fenêtres / baies	mesuré	→ Porte-fenêtres battantes avec sous-bassement Sud simple vitrage et volets battants avec ajours fixes Surface : 4,5 m <sup>2</sup> , Orientation : Sud, Inclinaison : > 75 °, Baie en fond et flan de loggia (< 3 m), U <sub>pn</sub> : 3,8 W/m <sup>2</sup> /°C, U <sub>w</sub> : 4,5 W/m <sup>2</sup> /°C, b : 1, Masque lointain (15 - 30°, 60 - 90°, 30 - 60°, 30 - 60°)
	mesuré	→ Porte-fenêtres battantes avec sous-bassement Sud simple vitrage et volets battants avec ajours fixes Surface : 4,5 m <sup>2</sup> , Orientation : Sud, Inclinaison : > 75 °, Baie en fond et flan de loggia (< 3 m), U <sub>pn</sub> : 3,8 W/m <sup>2</sup> /°C, U <sub>w</sub> : 4,5 W/m <sup>2</sup> /°C, b : 1, Masque lointain (15 - 30°, 60 - 90°, 30 - 60°, 30 - 60°)
portes	mesuré	→ Porte(s) bois / bois-métal opaque pleine Surface : 2 m <sup>2</sup> , U : 3,5 W/m <sup>2</sup> /°C, b : 0,35
ponts thermiques	mesuré	→ Liaison Mur 1 Sud / Porte-fenêtres Sud 1 : Psi : 0,31, Linéaire : 9 m, Liaison Mur 1 Sud / Porte-fenêtres Sud 2 : Psi : 0,31, Linéaire : 9 m, Liaison Mur 1 Sud / Fenêtres Sud : Psi : 0,31, Linéaire : 3 m, Liaison Mur 3 Inté / Porte : Psi : 0,25, Linéaire : 5 m,
	mesuré	→ Liaison Mur 1 Sud / Plafond : Psi : 0,43, Linéaire : 10 m,
	mesuré	→ Liaison Mur 1 Sud / Plafond : Psi : 0,43, Linéaire : 10 m,
	mesuré	→ Liaison Mur 1 Sud / Mur 2 Est : Psi : 0,365, Linéaire : 2,8 m,
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## Fiche technique du logement (suite)

équipements

système de ventilation	 observé	→ Naturelle par conduit Qvareq : 2, Smea : 4, Q4pa/m² : 301, Q4pa : 301, Hvent : 58, Hperm : 6
système de chauffage	 observé	→ Chauffage au bois et convecteurs bi onction Emetteurs: Convecteurs Ra : 1, Ri : 0,9, Rd : 1, Rg : 1, Ph : 0, Fch : 0
production d'eau chaude sanitaire	 tours	→ Chauffe-eau électrique installé il y a plus de 15 ans, ballon vertical Beco : 1627, Rd : 1, Rg : 1, Fh : 0, Tese : 1,71, Fecs : 0, Vs : 300
climatisation	 observé	→ néant



Explications personnalisées sur les éléments pouvant amener à des différences entre les consommations estimées et les consommations réelles :

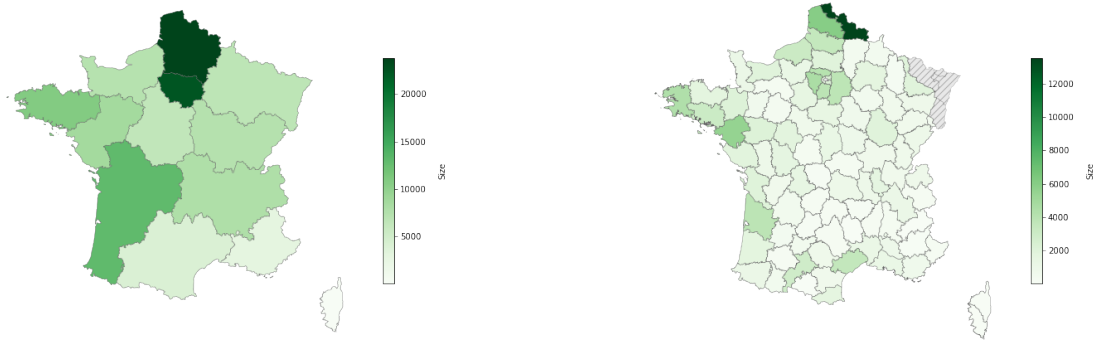
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## B Old and new frontiers of EPC ranks

EPC rank	Upper consumption frontier	
	Old version	New version
A	50	70
B	90	110
C	150	180
D	230	250
E	330	330
F	450	420
G	-	-

Table 7: Upper consumption frontiers for each EPC rank

## C Identification of dwellings



(a) Identification at the region level

(b) Identification at the department level

Figure 4: Identified houses inherited from the matching of the two databases

**Note:** The "Size" scale corresponds to the number of identified houses. Departments that are not identified are Haut-Rhin, Bas-Rhin and Moselle, as the three regions being a part of a legal specificity. This implies sells data are not accessible.

## D Catchment area zoning

## E Real-estate market tension



# F The importance of estimated energy consumption

**Table 8:** Results for the first specification, data before July 2021

<i>Dependent variable:</i>	<i>ln P</i>	
	(1) <b>Houses</b>	(2) <b>Apartments</b>
<b>EPC</b>		
B	0.1644*** (0.0078)	0.1193*** (0.0124)
C	0.0946*** (0.0038)	0.0651*** (0.0064)
D	-	-
E	-0.0872*** (0.0030)	-0.0401*** (0.0050)
F	-0.1797*** (0.0045)	-0.0818*** (0.0071)
G	-0.2594*** (0.0068)	-0.0856*** (0.0126)
<b>Gross surface</b>	0.0002 (0.0001)	0.0021*** (0.0007)
<b># Main rooms</b>	0.1230*** (0.0029)	0.2028*** (0.0127)
<b>Distance to center</b>	$1.08 \times 10^{-5}$ ( $6.87 \times 10^{-6}$ )	0.0006*** ( $3.15 \times 10^{-5}$ )
<b>Date of built</b>		
Before 1900	0.2052** (0.0835)	0.1196*** (0.0222)
1900-1950	0.1776** (0.0843)	-0.0146 (0.0162)
1950-1970	0.1851** (0.0844)	-0.1019*** (0.0171)
1970-1990	0.2319*** (0.0847)	-0.0142 (0.0154)
1990-2000	0.3044*** (0.0850)	0.0872*** (0.0176)
2000-2010	0.3209*** (0.0852)	0.1654*** (0.0175)
2010-2021	0.3511*** (0.0857)	0.1833*** (0.0205)
<b>Property age</b>	$-4.31 \times 10^{-5}$ ( $2.99 \times 10^{-5}$ )	$-1.61 \times 10^{-5}$ *** ( $5.35 \times 10^{-6}$ )
<i>Fixed-effects</i>		
Postcode	Yes	Yes
Transaction year	Yes	Yes
<i>Fit statistics</i>		
Observations	254,823	293,527
R <sup>2</sup>	0.62186	0.48552
Within R <sup>2</sup>	0.26641	0.29005

*Clustered (Postcode) standard-errors in parentheses*  
*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*

## G Trends in price

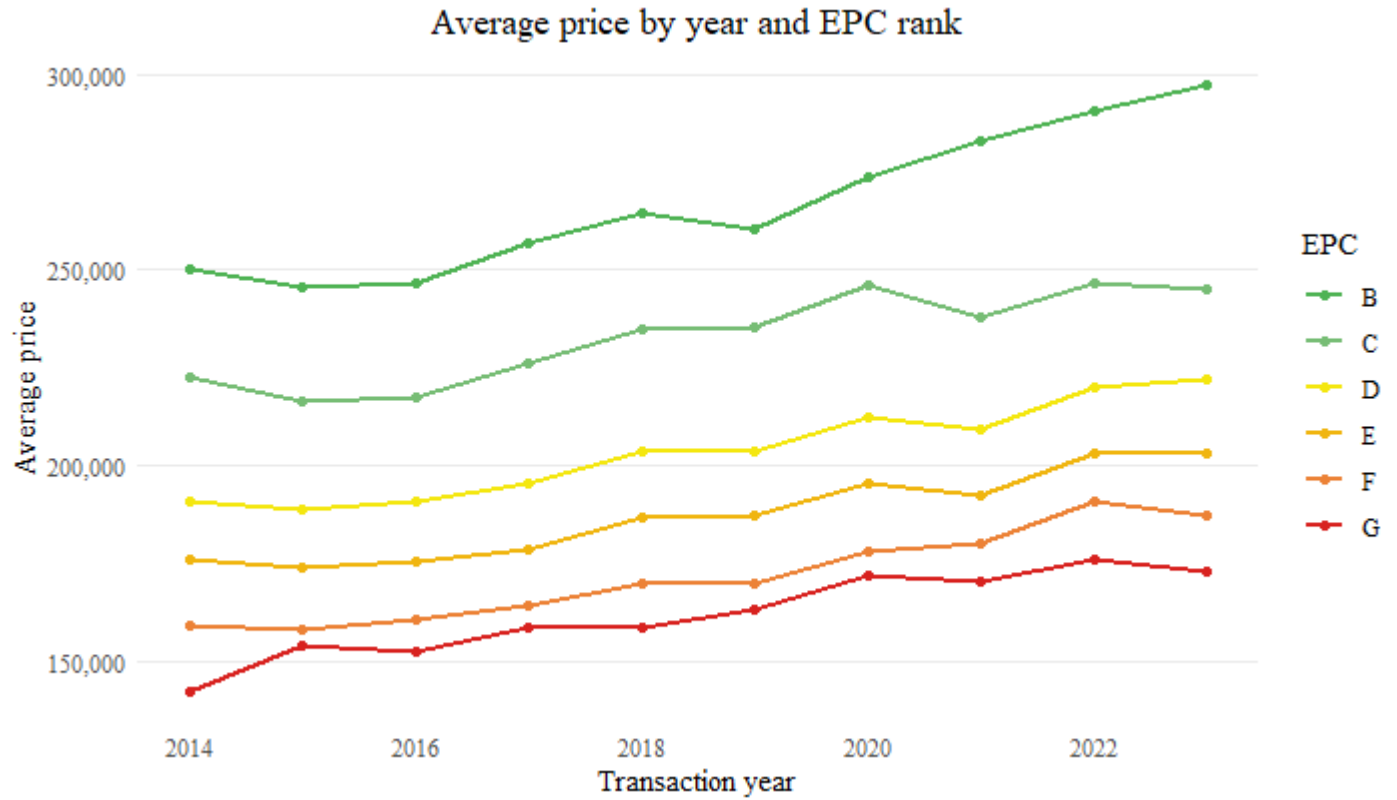


Figure 5: Average housing price by EPC rank

## H Consistency with data after 2021

**Table 9:** Results for the first specification, data after July 2021

<i>Dependent variable:</i>	$\ln P$	
	(1)	(2)
	Houses	Apartments
<b>EPC</b>		
B	0.1303*** (0.0142)	0.0286 (0.0306)
C	0.0585*** (0.0063)	0.0248*** (0.0095)
D	-	-
E	-0.0808*** (0.0060)	-0.0309*** (0.0117)
F	-0.1657*** (0.0099)	-0.0223 (0.0206)
G	-0.2575*** (0.0156)	-0.0095 (0.0321)
<b>Energy consumption</b>	-0.0001* ( $5.98 \times 10^{-5}$ )	-0.0002* (0.0001)
<b>Gross surface</b>	0.0056*** (0.0002)	0.0062*** (0.0006)
<b># Main rooms</b>	0.0146*** (0.0015)	0.0737*** (0.0042)
<b>Distance to center</b>	0.0005 (0.0008)	0.0668 (0.0410)
<b>Date of Built</b>		
Before 1900	-0.2419*** (0.0325)	-0.0149 (0.0445)
1900-1950	-0.2054*** (0.0226)	-0.0600** (0.0283)
1950-1970	-0.0782*** (0.0194)	-0.1481*** (0.0284)
1970-1990	-0.0284 (0.0173)	-0.1456*** (0.0251)
1990-2000	-0.0174 (0.0179)	-0.1024*** (0.0237)
2000-2010	-0.0143 (0.0171)	-0.0498** (0.0198)
<b>Property age</b>	0.0002 (0.0002)	0.0003 (0.0003)
<i>Fixed-effects</i>		
Postcode	Yes	Yes
Transaction year	Yes	Yes
<i>Fit statistics</i>		
Observations	71,748	76,994
R <sup>2</sup>	0.66858	0.31193
Within R <sup>2</sup>	0.40084	0.12621

*Clustered (Postcode) standard-errors in parentheses*  
*Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1*