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Ten years of price evaluation in a renovation market with volatile financial incentives: The effect of Energy Efficiency Obligation on residential market prices

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ABSTRACT

The package of legislative proposals under the designation “fit for 55”, emphasize the acceleration of the decarbonisation of sectors such as the building sector with increasingly demanding climate standards. Then, it is important to drive investments into the renovation of building stocks and to stimulate the refurbishment demand and ensure that the measures implemented are cost and environmental effective.

Thus, under the Energy efficiency Directive, the energy-saving obligation scheme (EEO) in France launched in 2006 incentivise the renovation of dwellings as around 70% of EEO delivered concern the households.

In that sense, the knowledge of renovation costs and their integration in techno-economic studies are key components to evaluate efficient measures.

In this context, we have been monitoring the prices of housing renovations carried out under the EEO scheme since 2009. We have carried out statistical analyses on a large sample to follow the evolution of prices (average growth rate) as well as the structure of the price distribution. These prices are compared to market prices outside the EEO scheme.

Thus, some renovation measures show various price evolutions and rarely a smooth evolution. These contrasting evolutions are analysed regarding the modification of the available financial incentives (EEO, tax credit) as well as the type of EEO (low-income vs. standard EEOs).

Introduction

The package of legislative proposals under the designation “fit for 55”, emphasize the acceleration of the decarbonisation of sectors such as the building sector. Then, it is important to drive investments into the renovation of building stocks and to stimulate the refurbishment demand and ensure that the measures implemented are cost and environmental effective.

Thus, under the Energy efficiency Directive, the Energy Efficiency Obligation (EEO) scheme in France launched in 2006 incentivise the renovation of dwellings as around 70% of EEO delivered concern the households (MTE 2022a). In that sense, the knowledge of renovation costs and their integration in techno-economic studies are key components to evaluate efficient measures and policies.

The energy renovation market of housing

The energy efficiency retrofits can be considered as a "belief and trust purchase" whose quality is unknown at the time of purchase and may become apparent only through usage (Giraudet et al. 2015) and high price is not a reflection of high quality.

There is therefore a lack of known reference to the prices of retrofit for the households, with few public publications available and only for dedicated readers (ADEME et al. 2019, Effinergie 2019, ADEME 2016, ADEME 2019). When reference is made to prices to the public it is often to address abuses (Que Choisir 2016, Que Choisir 2021) in relation to the financial incentives that clients may receive. In addition, prices are highly variable without direct correlation with the efficiency (Enertech 2021, Grandclément et al. 2018). Thus, these information asymmetries could lead to poor workmanship (Giraudet et al. 2018). Moreover, the households consider usually that a high price is linked to a good quality (Stolyarova 2016).

The price seen by the final customer (the subject of this study) is the result of the stacking of costs and margins of a number of stakeholders along the value chain (e.g. like wholesaler, distributor, and manufacturer as well as installer or craftsmen) but also intermediate (e.g. call center, business contribution) (ENEA consulting 2020).

The main price drivers have been studied previously through the analysis of invoices (Osso et al. 2017) showing that 50% at best of the variability of the retrofit price could be explained by: technical reasons (e.g. product quality, dwelling size) economic reasons (type of business, income), marketing variables (e.g. brand name) and location (climatic zone). Moreover, another study shows that the retrofit prices incorporate, in addition to technical dimensions, qualitative dimensions such as the accessibility of the site or the work quality of the company (being on-schedule, cleanliness of the work, etc.) (Osso et al. 2018).

The study from ADEME al. (2019) presents a breakdown of the cost of the housing renovation according to the share of labour and induced work. In the same vein, the ENEA Consulting (2020) study breaks down the value chain of the retrofit works into manufacturing, installation, and wholesale costs in the frame of the EEO scheme. To our knowledge, few studies look at the evolution of prices over the long term and only for certain types of equipment using renewable energy (e.g. Observ'ER 2021).

According to the French energy agency (Lacas 2021), the housing renovation market was about 30 billion Euro in 2019, a doubling since 2006. This amount is broken-down into 9.7 billion for the insulation of building shell, 9 billion for the replacement of windows, 358 million for the mechanical ventilation, 3.4 billion for thermodynamic equipment (space heating and sanitary hot water) and 3.1 billion for wood space heating.

The EEO scheme to support the energy efficiency measures

There are various schemes to incentive the implementation of energy efficiency action in France: EEOs, tax credit, reduced VAT, soft loan, which can be cumulated. We should note that the tax credit for which the renovation actions studied here are eligible depends now on the household income according to 4 thresholds (MEFR 2022, ADEME 2022) but was in the past a 30% rebate without income consideration. The number of assisted housing units (excluding windows) by all the schemes between 2016 and 2019 increased from 1 million to 1.8 million per year (ONRE 2021).

The French EEO scheme will not be described here as it was already presented in various paper (Bertoldi et al. 2010, ENSPOL 2015, Rosenow & Bayer 2017, Osso et al. 2020, Osso et al. 2021). An important point to note is that since 2016 there is an additional obligation related to fuel poverty (low-income EEOs) associated with higher grants leading to two types of certificate.

Concerning the EEO scheme, from an energy user's perspective, an EEO scheme acts both as an energy efficiency subsidy (e.g. grant for housing retrofit) and as a tax on the price of energy (Giraudet et al. 2020). From a broader perspective, an EEO scheme may seem simple in as much as it relies on a combination of a tax on energy suppliers and a financial incentive for energy efficiency actors (e.g. manufacturer, installer) (Bye & Bruvoll 2008).

The EEO bonus programme

We need to detail the EEO bonus programme ("Helping hand energy saving bonus"[1]) which have an impact on the operations carried out and on retrofit prices in certain cases (see Table 1 for eligible measure to this bonus programme). Initially this programme was dedicated to the low-income households to help them to replace their fossil boiler, in January 2019 it was enlarged with great success to all households (with still a higher premium for low-income households) and to more eligible actions (roof and floor insulation, biomass boiler and wood stove, air-to-water heat pump). In July 2021, the incentive for insulation for low-income households was reduced and will be discontinued in July 2022 as well as the subsidies for fossil boilers (Euractiv 2021, MTE 2022a). It should be noted that this bonus programme imposes a minimum premium to avoid the impact of fluctuations in the EEO price[2].

From 2019 to 2021, the EEO bonus programme incentives 788,989 space heating retrofits and 1.96 million insulation works (roof and floor) for a grant of just over 4 billion euros (MTE 2022b). It should be noted that it had 74 signatory entities to this bonus programme.

Methodologies and data source

This study focuses on the prices of renovation work in the residential sector and mainly in individual housing. The sample sizes of the energy efficiency measures studied vary between actions and years ranging from a few hundred to over 10,000 invoices (Table 1).

To conduct this study, we have relied on a simplified large-scale analysis of invoice (price inc. VAT of supplied and installed works) allowing historical monitoring over the period 2009-2021 of energy efficiency retrofits valued in EEO certificate. To ensure that our sample has no large bias we compare our results with those published elsewhere. We have also in the past compared this massive analysis with a detailed analysis of individual invoices (Grandclément et al. 2018) to validate this approach.

We have filtered the invoices presenting several EEO eligible works, but other retrofit works not eligible to EEO may be present on the bill. This partly explains the presence of renovations with very high costs and the need of data filtering of the highest values (reduction of the distribution queue) (Figure 1).

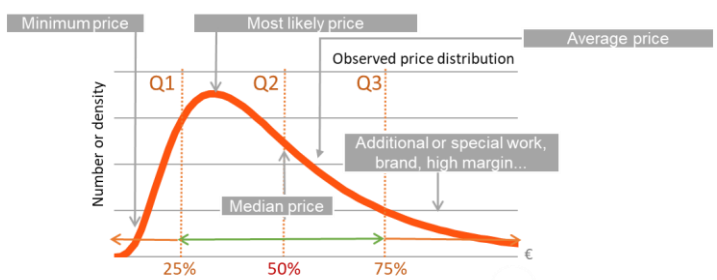

Figure 1: how to interpret the price distribution (unimodal, right-spread asymmetric). Q1: 1st quartile, Q2: 2nd quartile, Q3: 3rd quartile.

Building renovation measures

We have study 11 different energy efficiency measures eligible to EEO certificate including insulation (4), space heating (5) and sanitary hot water (2). We do not detail all the retrofit works studied due to lack of space and a sum up is available in Table 1. Below we present in detail only the retrofit works that we find most

[1] In French "coup de pouce chauffage et isolation » (https://www.ecologie.gouv.fr/coup-pouce-chauffage-et-isolation).
[2] May 2022, spot price 5.87€/MWhc against 8.5€/MWhc in February 2020.

interesting in terms of the link between EEO subsidies and price change to exemplify interaction between EEO financial incentive and market response.

We must keep in mind that concerning most retrofits, the technical values stay more or less the same with few exceptions. So, the up-front cost of the renovation ca be compared from one year to another without much uncertainty coming from the technical side.

To compare the observed average annual growth rate (AAGR) of the retrofit price, we must keep in mind that the French inflation rate between 2009 and 2021 was +0.91%/yr (France Inflation, 2022) and the building price index (BT50)[3] (INSEE 2021) was about +1.76%/yr from 2010 to 2021 (Figure 2). Between 2018 and 2021, the AAGR inflation rate was +1.67%/yr and the BT50 +3.25%/yr. We must notice that between 2020 and 2021, the BT50 index increase by +5.76%/yr due to the economic recovery and the scarcity of materials.

Table 1. Median price (y2021), price change and EEO per retrofit average value change.

Retrofit work	Median price 2021 (€)	Median price change 2009-2021 (AAGR in %/y)	Median price change 2018-2021 (AAGR in %/yr)	EEO/measure change 2018-2021 (%)	Retrofits in the bonus programme (2019-2021)	Average sample size over years
Roof and loft insulation	1,541	-5.24	-54	+7	1,478,301	10,000
Wall insulation (inc. ITI and ETI)	15,877	+3.19	+28	+83	ineligible	4,500
Floor insulation	1,364	-13.3*	-23	-55	482,736	10,000
Double glazing windows	3,858	+0.78**	-20	+63	ineligible	10,000
Air-to-water heat pump	13,258	-1.03	-17	+509	≈300,000×	9,000
High efficiency fossil boiler	4,100	-0.92	-4	+194	445,182	5,000
Wood stove or insert	5,150	+1.3	+3	+85	≈30,000×	10,000
Biomass boiler	15,167	+1.66	+61	+297		400
Air-to-air heat pump	3,131	-4.17	-31	+27	ineligible	10,000
Heat pump water heater	2,868	-3.27**	-45	+17	ineligible	3,000
Individual solar water heater	6,957	n.a.	+11	+17	ineligible	60

Source: Authors, MTE (2022a). *2015-2021, **2011-2021, ×authors' assessment from MTE (2022a).

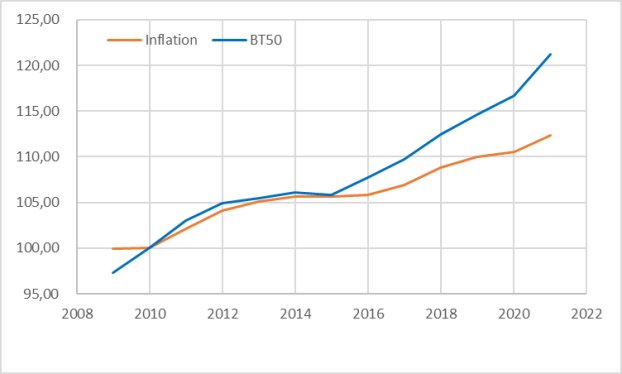

Figure 2: Building Index evolution (BT50 all trades maintenance -in second-hand buildings) and inflation index from 2009 to 2021 (INSEE 2021).

[3] BT50: all trades maintenance (in second-hand buildings). The Building Indexes are cost indices of different activities in the construction sector used for contract indexation purposes (INSEE). Various building index exist according to the various building trades, but it is sometime difficult to link the energy efficiency implemented measures and the building trades that encompasses too much different work.

Concerning the EEO certificate valorised with a retrofit measure, a strong increase between 2018 and 2021 is because of the bonus programme[4] (Table 1). This is particularly true for boilers and air-to-water heat pumps and we must keep in mind that the amount of EEO is proportional to the financial incentive received by the household.

Roof and loft insulation

The price changes between 2009 and 2021 for roof and loft insulation (Figure 3) show a contrasted evolution with a strong break in 2019. This break is linked to the implementation of the bonus programmes that leads to the massification of 1€ offer[5] (Osso et al. 2020, ENEA Consulting 2020). We must notice that the insulated area is remaining stable around 75 m² like the surface area observed elsewhere (ADEME et al. 2019).

Concerning the price per unit area (figure 3) its distribution has a maximum centred on 17 €/m² with a large width. The price near zero corresponds to offers at 1€ for the customer as indicated directly on his invoice but the peak distribution at 17€/m² can also correspond to these offers even if the invoice does not show the premium deduction. This distribution is the result of different technical gestures (blown-in roof insulation, unrolled wool insulation and converted loft insulation) with increasing prices respectively. For example, insulation in the slope is about 120€/m² (Enertech 2021). We should note that EEO premiums increased from 13-17€/m² between 2014-2018 to 27€/m² between 2018-2021 and less than 10€/m² in January 2022 (Batirama 2022).

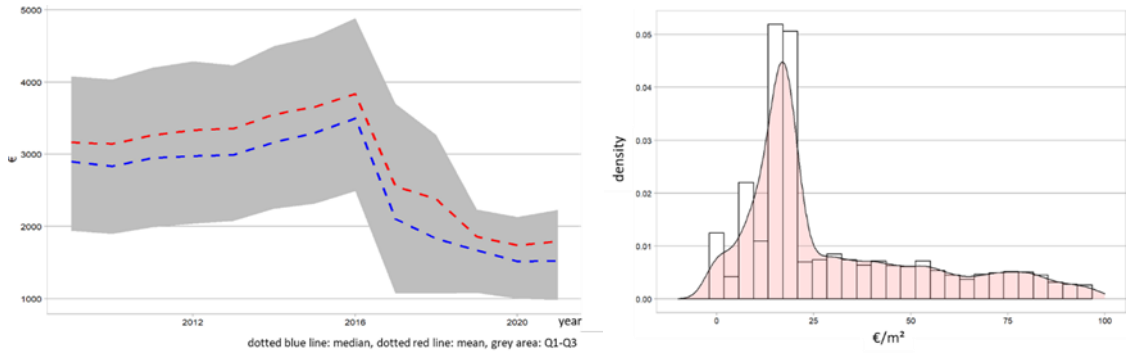

Figure 3: price changes between 2009 and 2021 for roof and loft insulation (left) and (b) price per unit area distribution (y2019) (right).

The observed median price of a roof insulation is about 1,500€ and close to the median price reported elsewhere (1,676€ for unoccupied attic) by ADEME et al. (2019). According to ENEA consulting (2020) the price of the blown-in roof insulation was about 12€/m² in 2020. This low cost is not reported elsewhere with a price of 43 €/m² for unoccupied attic (Enertech 2021).

Wall Insulation

For wall insulation, the price changes between 2009 and 2021 (Figure 4) show a sharp decline in 2019 that began in 2017. In 2021, the price rises again to its pre-drop level. This can be explained by the presence of two different insulation techniques implemented under the same EEO measure (internal (ITI) and external (ETI) thermal insulation) with very different costs. In fact, within the framework of the EEO, there is no difference in EEO valuation depending on whether ITI or ETI is used.

[4] These additional "savings" are not reportable under EED, Article 7 (MTE 2022b).
[5] 1 Euro paid by the household the remainder borne by the EEO grant.

The share of these techniques could be assessed using a Gaussian Mixture Model (GMM[6]) leading to a share of 23% of ITIs and 77% of ETIs in the 2021 price distribution. In addition (Figure 5), clustering[7] can be performed to separate the different retrofits with a price for cluster 1 of 61 €/m² on average and of 200 €/m² for the other clusters (Figure 5). The difference between clusters 2, 3 and 4 lies in the insulated area. These prices are close to those that can be found in literature: 87€/m² for ITI and 159€/m² for ETI (Enertech 2021).

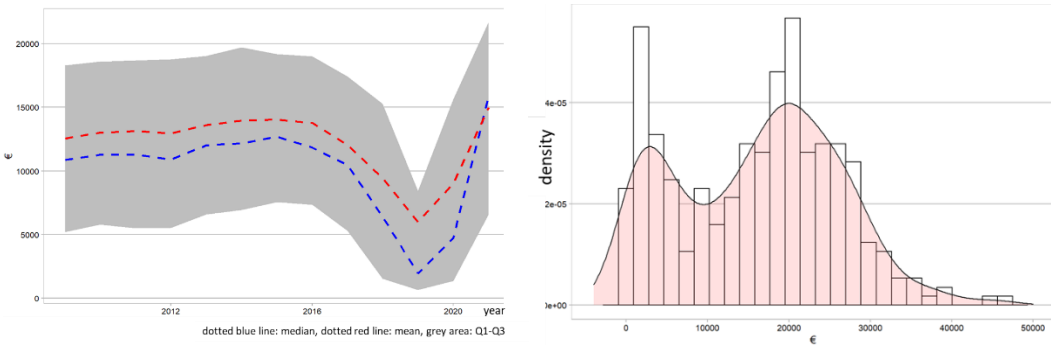

Figure 4: price changes between 2009 and 2021 for wall insulation (left) and price distribution (y2021) (right).

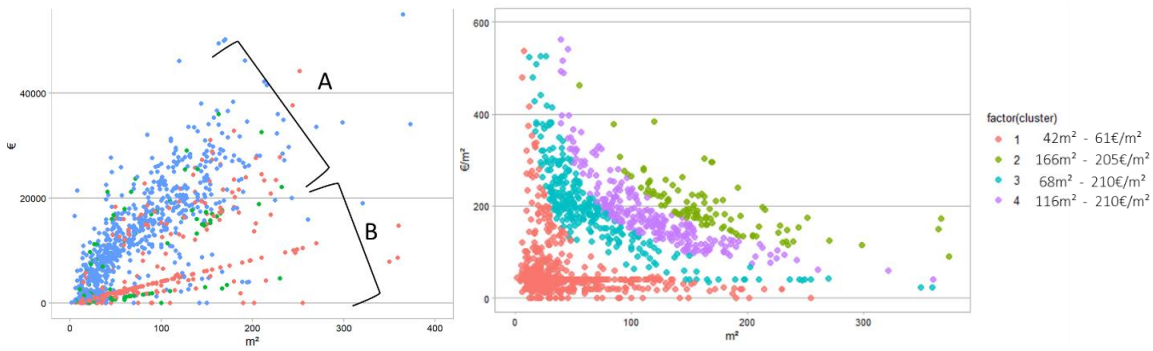

Figure 5: retrofit price according to the insulated area (left) (A: ETI; B: ITI) and clustering (right) (y2020).

The evolution of the shares of the different types of insulation is to be compared with the different type of EEOs with ITI for low-income households and ETI for standard households (Figure 6). Thus, it is possible to provide wall insulation for low-income households with a financial incentive that sufficiently covers the retrofit price when the technical solution is relatively inexpensive.

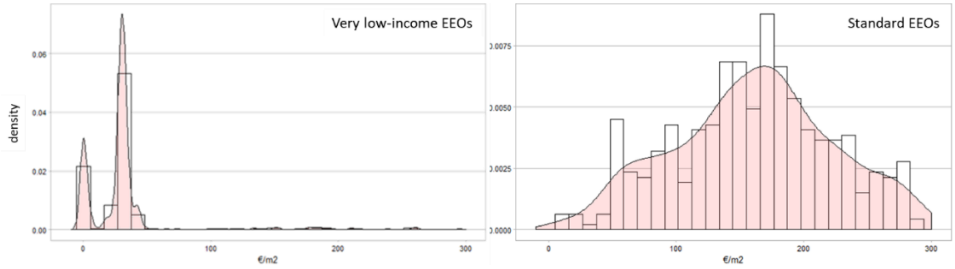

Figure 6: price distribution of the price per unit area for wall insulation according to EEOs type (low-income vs. standard) (y2018).

[6] Multivariate gaussian mixture model (Benaglia et al. 2009).
[7] K-means clustering (R Core Team 2012).

The observed median price of a wall insulation is about 2,496€ for ITI and 19,777€ for ETI and a little higher than the median price reported elsewhere: 1,740€ for ITI and 12,516€ for ETI (ADEME et al. 2019).

Double glazed window

The evolution of double-glazed window replacement prices has shown a steady increase since 2012 with an AAGR about +0.78%/yr (Figure 7). During the period under review, the number of windows replaced is stable about 4 units per housing for a current median price of 3,858€.

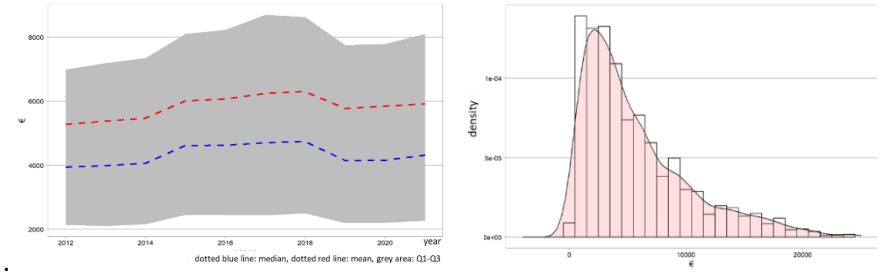

Figure 7: price changes between 2012 and 2021 for double glazed windows (left) and price distribution (y2021) (right).

In the end of 2014, the windows replacement was eligible to the tax credit as part of a simplification of the scheme (i.e. a single rate of 30%) (Fenetre01 2015) compared to no subsidy previously (FFB 2013). But between 2017 and 2019, due to the violent stop on window replacement caused by the refocusing of the tax credit, this market, valued at 9 billion in 2019, showed a drop of -20% compared to 2017 (Lacas 2021). These past events could be linked with the rapid increase of the price in 2014 and its decrease in 2018.

Air-to-water heat pump

The price changes between 2009 and 2021 (Figure 8) for an air-to-water heat pump show a contrasted evolution with a strong break in 2020. This break could be linked to the implementation of the bonus programmes started in 2019 (Osso et al. 2020) and consequently the rapid growth of the market which almost triples between 2018 and 2021 from 96,024 units to 267,221 units[8] (Uniclima 2022). These figures include new construction and renovation, but EEO-assisted air-to-water heat pumps account for about half the market between 2019 and 2021 (around 300,000 against 600,000 units).

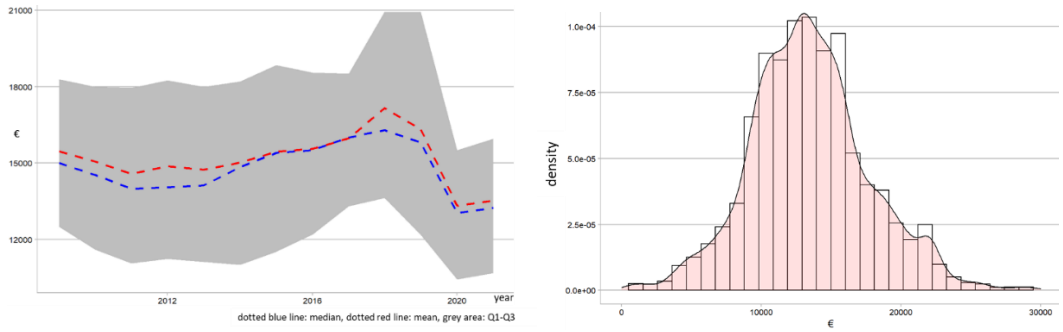

Figure 8: price changes between 2009 and 2021 for an air-to-water heat pump (left) and price distribution (y2021) (right).

[8] Including new building and renovation market but the hight power heat pumps (>6 kW) installed mainly in existing building shows a stronger growth (+60% between 2020-2021) than that of the lower power installed in new buildings (+25%).

The observed median price of an air-to-water heat pump is about 13,260€ a little higher than the median price reported elsewhere: 12,668€ in ADEME et al. (2019). These prices differences that can be found in the various publications are easy to understand due to the dispersion of the prices observed (1st quartile = 11,100€, 3rd quartile = 15,400€).

Thus, Observ'ER (2021) gives high and low-price ranges (excluding installation) of 4,600€ to 13,000€ and installation prices of 800 to 4,000€. Similarly, Que Choisir (2021) gives an average price of 13,779€ with price differences between 9,166€ and 21,300€ and BatiEtude (2022) prices between 10,000€ and 29,000€. According to ENEA Consulting (2020) the price of an air-to-water heat pump was about 11,417€ in 2020 and according to Enertech (2021) was 13,700€.

Efficient fossil boiler

The price changes between 2009 and 2021 (Figure 9) for a fossil (gas or fuel oil) boiler show a contrasted evolution with a decline at the beginning of the period and some instability since 2019. These instabilities can be linked to the market for condensing boilers, which increases until 2018 and then decreases until 2020 before increasing again in 2021 (Uniclima 2022).

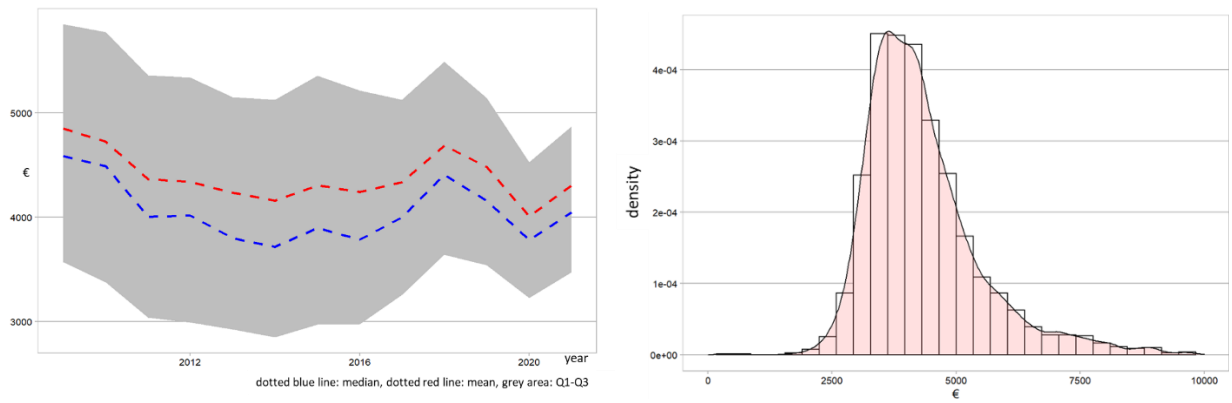

Figure 9: price changes between 2009 and 2021 for an efficient fossil boiler (left) and price distribution (y2021) (right).

The observed median price of a fossil boiler is about 4,100€ a little lower than the median price reported elsewhere by ADEME et al. (2019) (5,286€). According to ENEA consulting (2020) the price of a gas boiler was about 2,700€ in 2020.

Air-to-air heat pump

The price of the installation of an air-to-air heat pump is relatively stable over time even if a decrease was observed between 2009 and 2012 (Figure 10). If the price distribution is large, this can be explained by technical factors like the surface area heated by the heat pump, the number of indoor units and/or the use of single or multi-split outdoor units. However, according to the type of EEOs (i.e. low-income vs. standard) linked to different financial incentive, we can observe for low-income households very high prices (>15,000€) that can be linked to important incentives (e.g. EEO and tax credit) raising the question of the potential capture of these incentives by some opportunistic installers. Fortunately, this does not seem to be most cases.

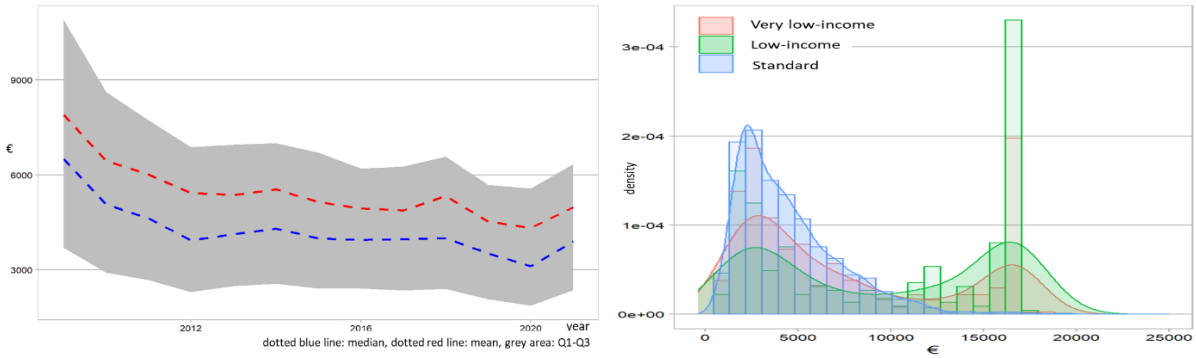

Figure 10: price changes between 2009 and 2021 for an air-to-air heat pump (left) and price distribution according to type of EEOs (y2021) (right).

The observed median price of an air-to-air heat pump is about 4,000€ that is lower than the median price reported by ADEME et al. (2019) (6,629€) and our figure is below the price of the 1st quartile (4699€) but higher than the C5 percentile (3,321€). The observed Q1-Q3 price range is 2,369€ - 6,366€ in this study. To complete this comparison, another market study (Batietude 2022) presents an average price of 5,900€ with a range of 2,000€ to 20,000€.

It can be noted that the development of the air-to-air market[9] does not seem to have a direct influence on the price since 2012 (Uniclima 2022).

Conclusion and policy implication

Above all, it should be noted that it remains difficult to establish causal links between past events and price changes and we can only present the context and make assumptions that we submit for discussion. This being said, we can highlight the possible impact of changes in subsidies linked to EEOs (or other types of grants like the tax credit) on the evolution of retrofit prices.

The combination of financial incentives (EEO bonus, tax credit), especially for low-income households, means that most of the cost of renovation work is covered by grants even more so as the techniques implemented are adapted to the least expensive solutions.

Historically, renovation works have not been standard, and this partly explains the wide distribution of prices for the same type of work. However, the price distribution analysis makes it possible to highlight the most common prices and to follow their evolution over time. The development of the market in volume is therefore not always associated with a fall in prices because financial incentives interfere, and few renovations show a stable and continuous evolution of prices over time as expected following building price index (BT50) that appears to be too aggregated. We must note that when the renovation price increase due to exogenous effects (economic recovery, scarcity oof materials) this interact with EEO aid and cause it to rise to maintain the same level of subsidy.

The impact of incentives on prices materializes in different ways. The choice of technical solutions adapted to the level of subsidy makes it possible to produce low-income EEOs without financial input from the beneficiary. Thus, within the framework of the EEO and for some insulation measures (e.g. blown-in roof insulation vs. unrolled wool insulation), a certain level of industrialisation has emerged to enable 1€ offers especially for low-income household. This industrialisation relies on a dedicated technique (blown-in insulation) with a very low cost. But as companies have grown on dedicated subsidies linked to the EEOs bonus programme and now, with the end of this programme in mid-2021 for insulation, they are laying off[10] (Le Moniteur 2022).

[9] 333,775 outoor units sold in 2012 and 837,629 units in 2021. A market recently driven by multi-splits (Uniclima 2022).

[10] 13,000 jobs have been lost in the insulation sector following the end of the subsidies and the entry into force of the 5th period.

Similarly, with regard to wall insulation, the least expensive technique (i.e. ITI) is chosen to produce EEOs for low-income households and the ETI is reserved for higher income households.

Adjusting the price according to the existence of subsidy by the installer to maximise the bill. The installation of double-glazed windows seems to have been impacted by the tax credit grant, with a higher price when the action was eligible to tax credit in addition to EEO. This could be viewed as an adaption of the renovation price to the willingness to pay of households.

Where subsidies are potentially high (EEO and tax credit for a low-income household) as in the case of the air-to-air heat pump, this can lead to maximising the billing and/or the number of works by the installer. This is a way of sharing the subsidy between the customer and the installer by differentiating the renovation prices according to the type of household.

In a market mechanism such as an EEO scheme, unlike a tax credit, it is difficult to assess in advance the share of aid on the up-front cost. However, we have seen in the past that the price of EEOs can be extremely variable depending on the tensions in the scheme. This is partly why the EEO bonus programmes impose minimum grants to increase certain energy efficiency actions promoted by the French ministry. The consequence of these higher subsidies is that they favour these energy efficiency actions but also lead to impacts on prices or technologies implemented.

It should therefore be noted beyond price that it is difficult for public authorities to manage the EEO scheme finely without negative effects such as fraud or quality problems during a massification of certain energy efficiency measures (Osso et al. 2019, ENEA Consulting).

We must add the need for a short- to medium-term stability of the EEO scheme, to avoid breaking the momentum that is detrimental to the development of a structured building sectors that is virtuous in terms of compliance with the renovation work and in terms of price due to the gains inherent in the scale effects.

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