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Housing's energy efficiency: renovating public action

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Housing's energy efficiency is one of the most important aspects of the environmental transition. Achieving this transition will help to reduce greenhouse gas emissions from one of the largest emitting sectors, as well as household energy bills and illnesses linked to thermal discomfort. National targets in this area are therefore ambitious: the entire housing stock will have to be 'low energy' by 2050. The demanding standards for new buildings should contribute to this goal. However, given the low rate of new construction, renovating the existing stock remains the biggest challenge to undertake.

Considerable resources have therefore been mobilised in recent years to improve the energy efficiency of housing. The aid provided has been criticised for a number of reasons, including uncertainties about the actual performance of the investments, unreliable technical benchmarks and a lack of targeting of the aid schemes.

This note therefore has several objectives:

– Estimating the contribution of housing renovation to meeting climate change targets

– Defining the scope of public policies for the renovation of private dwellings

– Evaluating public policy instruments in the light of environmental and social justice issues.

A detailed model of the housing stock shows that only 5% of this stock is profitable for private individuals to renovate due to the many barriers to investment. Removing these barriers makes this figure rise to 26%, which is still far from the 55% of the housing stock for which renovation is socially profitable from an environmental and health point of view. Hence, Public intervention is justified to encourage households to renovate their homes.

The report suggests ways to improve current policies and make them more effective. The annual aid budget should be ring-fenced at its current level, i.e. €8 billion per year until 2050. Part of this amount could be financed by a contribution from energy suppliers, replacing the system of energy saving certificates. Support should be better targeted at low-income households and those with poor insulation, ensuring that insulation and improvements to heating systems are coordinated to provide a low-carbon solution. This could include an active approach by government departments to identify the best opportunities for renovation. To increase supply in the renovation market, the RGE label could be made more accessible to contractors, along with more systematic ex-post checks on the quality of work. These changes should be accompanied by a strengthening of the evaluation infrastructure, based on an optimised data collection system and better matching with other administrative data.

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The building sector is one of the largest contributors to greenhouse gas emissions in France, accounting for 20% of national emissions. Almost two thirds of emissions come from residential buildings and are mainly due to heating, making this sector a priority for decarbonisation.[1] To this end, the National Low Carbon Strategy (SNBC) set specific targets for energy-efficient renovation of dwellings: 370,000 efficient renovations per year, accelerating to 700,000 by 2030, with the aim of generalising the Low Energy Building Standard (LEBS) by 2050.[2] These objectives are ambitious, given the current annual rate of around 66,000 energy-efficient renovations reported by the Agence nationale de l'habitat (Anah) in 2022.

In addition to its climate benefits, energy-efficient home renovation has significant co-benefits that justify public support. It reduces the energy bills of households, particularly those on low incomes who are more vulnerable to cold-related health problems. Renovation also contributes to the country's energy independence, which has become a major issue again in the last two years.

The maxim stating that "the cleanest and cheapest energy is the energy not used" has led successive governments to introduce a range of energy efficiency policies, in addition to cross-sectoral measures to reduce CO_2 emissions, such as the carbon tax. These measures initially relied on incentive instruments: reduced VAT in 1999, a tax credit in 2005, which became MaPrimeRénov' (MPR) in 2020, energy saving certificates (CEE) in 2006 and the zero-interest eco-loan (EPTZ) in 2009. It has gradually been supplemented by information tools, with the obligation, introduced in 2007, to produce an energy diagnosis (DPE) for any new sale or rental of a dwelling, and to use a tradesman "recognised as an environmental guarantor" (RGE label) in order to benefit from the various subsidies in 2014. More recently, coercive measures were rolled out, such as the ban on renting low-energy dwellings, which will be phased in between 2023 (G+ dwellings) and 2034 (gradual extension to G, F and E dwellings).

However, questions remain about the ends and means of the policy to support energy renovation. How much energy will be saved? What contribution should energy renovation make to meeting climate objectives and, more generally, to social progress? Does current policy contribute to these goals in a fair and effective way?

This note is based on unprecedented modelling of residential energy renovation, using assumptions that reflect the current state of knowledge as accurately as possible. Additional analysis is provided in the four focuses associated with this report.[3] Taken together, the work carried out makes it possible to quantify the impact of energy renovation, clarify the motivations behind public policy in favour of it, and assess the needs in terms of public support. The note defends an ambitious reform of public policies and makes recommendations along these lines.

The private profitability of energy renovation

Renovating a house to make it more energy efficient is an investment decision for the homeowner, who compares the costs of the renovation with the expected benefits. Assessing these costs and benefits is a complex process, as each energy renovation is a "tailor-made" service that must be adapted to the specific characteristics of each home. Here we summarize what is currently known about the structure of costs and the valuation of private benefits. We then estimate the proportion of efficient renovations, i.e. those that are strictly profitable from the point of view of the private investor in the absence of any financial support, using an economic model that simulates the renovation choices of all French households (see Box 1).[4] A renovation is considered efficient if it reaches the consumption thresholds of labels A or B of the DPE (according to the BBC standard). For the least efficient homes, this requires combining several insulation measures in a single step and installing a low-carbon heating system.[5]

We opted for an ambitious renovation target that combines insulation with a change of heating system. While replacing gas or oil boilers with heat pumps is an important part of the renovation, encouraging households to do this alone would not only lead to more limited energy savings for them, but would also pose specific risks:

- On climate: carbon gains are lower in the long term than in homes that would also have been insulated, and do not contribute to meeting decarbonisation targets
- On the electricity provision: on a national scale, the

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[1] SDES (2023): Chiffres clés du climat France, Europe et Monde, Édition 2023.

[2] Revised National Low Carbon Strategy, March 2020.

[3] Fack G., Fournel J., Maisonneuve F., Paris H., Salem A. (2024): "Performance énergétique du logement et consommation d'énergie", *Analyses complémentaires au Focus* n° 103, June; Astier et al. (2024): "Performance énergétique du logement et consommation d'énergie : les enseignements des données bancaires", January; Aja P.-R., Ouadi L., Péron M. (2024): "Améliorer la fiabilité du DPE :une évaluation des réformes de 2021", *Focus* no. 105, June; Giraudet L.-G., Vivier L. (2024): "Analyse socio-économique des gains à la rénovation", CAE, *Focus* no. 106, June; Giraudet L.-G. (2024): "Efficacité et effets distributifs des politiques publiques de rénovation énergétique", CAE, Focus no. 107, June.

[4] For a detailed explanation of the model, see Giraudet L.-G., Vivier L. (2024): "Analyse socio-économique des gains à la rénovation" CAE, *Focus* no. 106.

[5] Additional simulations detailed in *Focus* no. 106 show that achieving BBC standards using insulation alone generates significantly lower emission reductions, at a higher cost.

slightest saving in energy consumption raises some questions about the ability of the electricity system to support an increase in demand, and the widespread installation of heat pumps without insulation is incompatible with RTE (Electricity Transmission System)'s scenarios for the future of the electricity system[6]

- On households: installing a heat pump without insulation may cost less initially, but the extra electricity consumption associated with it represents an additional cost to households in the future.

Thus, the following analysis focuses on the ways to achieve these objectives as effectively as possible.

The costs of renovation

Energy renovation involves a variety of costs for investors: technical, financial and induced.

Technical costs are the most tangible. They correspond to the material and labour costs charged to the investor. Estimates in the literature suggest that it costs between €19 and €46 per square foot of living space to achieve BBC standards, giving an average cost of €35,000 for a 1076 square feet house. This cost varies little with the initial energy performance, reflecting a cost-benefit ratio that decreases with the scale of the renovation. However, poorly coordinated work on the various insulation and heating systems can result in efficiency losses of 20% to 40%.

With sums running into tens of thousands of euros, the work also has a financial cost, which can be understood as the opportunity cost of the savings used to finance part of the work (and therefore no longer available for an alternative investment), plus the cost of credit if the household has to take out a loan.

In addition to these material costs, there are also induced costs, both monetary and non-monetary. Households have to spend money upfront, for example on an energy audit. They then incur non-monetary costs, such as the time spent finding a tradesman, preparing an application for financial aid, or even finding a solution for relocation if the renovation works are too inconvenient to live with.

Energy efficiency gains

The private benefits of renovation come from the energy savings achieved, that have been the subject of both academic and public debate.

Energy savings: theoretical estimates versus real data

Prior to renovation, the expected energy savings are estimated using conventional methods that take into account the initial physical characteristics of the building and its heating system, the renovation work eventually already carried out and normative assumptions about user behaviour. The scientific literature has highlighted a significant gap between the results of these simulations and the actual savings measured after the investment.[7] The recent study by Astier et al.[8] shows that the difference in energy consumption between the best and worst performing dwellings is five times smaller when measured on the basis of energy bills than when measured on the basis of the DPE label calculated in France using the 3CL method. Three reasons are generally given to explain the discrepancy between predicted and realised energy savings: behavioural adjustments, modelling errors and quality defects.

Far from being constant, as assumed in thermal simulation models, households' heating behaviour varies according to the energy performance of their home and their income. The higher the energy performance of the home, the more affordable the thermal comfort, which leads households to increase the intensity of use of their heating system (measured by the set temperature or the number of rooms heated). According to empirical studies, this "rebound effect" leads to energy savings that are 20% lower than those predicted for constant behaviour.[9] The higher the household income, the more pronounced the effect. At the other end of the spectrum, low-income households living in poorly performing dwellings cannot afford high heating bills, leading them to lower their thermostats, sometimes below the recommended 19°C, exposing themselves to health problems.

Modelling errors correspond to incorrect parameters being set for the physical characteristics of dwellings in simulation models. These errors are at the root of the unreliability of the DPE, which is regularly criticised in public debate. Part of the problem is due to unintentional measurement errors, as energy performance is inherently difficult to diagnose without destructive intervention. However, some of the errors are due to manipulation. The analysis of the distribution of DPE labels in the French housing stock carried out by Aja, Ouadi

[6] Ademe (2024): "Decarbonising heating: what role for heat pumps", Avis technique, March; RTE (2020): *Reducing CO_2 emissions, impact on the electricity system: what contribution will heating in buildings make by 2035?*

[7] For France, see Allibe B. (2012): *Modélisation des consommations d'énergie du secteur résidentiel français à long terme-Amélioration du réalisme comportemental et scénarios volontaristes*, Thesis, École des Hautes Études en Sciences Sociales (EHESS); Charlier D. (2021): "Explaining the energy performance gap in buildings with a latent profile analysis", *Energy Policy* 156, 112480; Blaise G. and Glachant M. (2019): "Quel est l'impact des travaux de rénovation énergétique des logements sur la consommation d'énergie", *La Revue de l'énergie* n° 646, septembre-octobre.

[8] Astier et al. (2024): op.cit; Fack G., Fournel J., Maisonneuve F., Paris H., Salem A. (2024): *op.cit.*

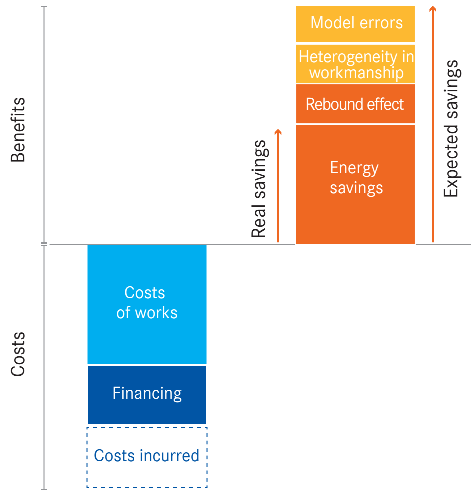
[9] Sorrell S. et al (2007): *The Rebound Effect: An Assessment of the Evidence for Economy-Wide Energy Savings from Improved Energy Efficiency*, January.

and Péron[10] shows an excess of dwellings on the favourable side of the thresholds between classes and a deficit on the unfavourable side, suggesting a systematic underestimation of consumption that allows the performance of the dwellings to be "outclassed".

Quality defects are failures in the work carried out (poor quality materials, installation errors, etc.) that result in actual consumption being higher than expected. In France, a study by Enertech[11] shows that 40% more heating is consumed in dwellings with quality defects. The problem is linked to the partly unobservable nature of energy performance, which creates information asymmetries between the owners who finance the work and the contractors who carry it out.[12]

What is the relative importance of these three sources of the gap between theoretical and actual returns? A recent study[13] carried out in the United States provides a first answer to this question. It estimates the gap between theoretical and actual consumption at 50%, of which 10 percentage points (pp) are due to behavioural adjustments, 20 pp to modelling errors and 20 pp to quality defects. In terms of actual savings, these effects are 20%, 40% and 40% respectively. These results are consistent with literature estimates for each effect. Figure 1 summarises the costs (technical and financial) and real benefits of energy renovation.

Figure 1: Private costs and benefits of energy renovation



Note: Schematic representation of the theoretical and real costs and benefits of investing in energy renovation for households. The ratio of costs to benefits varies depending on the situation. The benefits do not include any premium on the property market (green value). Workmanship refers to the quality of the implementation of retrofits, which results from the efforts of individual contractors, auditors, and agency quality control inspectors.

Making the most of energy savings for households

For households, the private benefits of renovations consist of lower energy bills and increased comfort. When capitalised into the value of the property, these benefits can generate a resale premium, known as 'green value'. Green value depends on the time horizon used to project energy savings, the importance attached to the future and assumptions about energy price trends.

Studies carried out in several European cities indicate the existence of a sales premium for the most energy efficient dwellings. In France, its amount is close to the technical cost of the work.[14] However, on the rental market, evidence that energy performance is capitalised in rents is weaker.[15]

In this note, we have chosen to assess the private benefits of renovations based on estimates of the gains in energy bills and comfort (see Box 1). On this basis, it is possible to determine the discounted costs and benefits of the optimal combination of renovation measures to achieve BBC levels for each type of dwelling, depending on the characteristics of the owners and, where appropriate, the tenants. We calculate the net present value (NPV), which is the sum of the discounted benefits minus the renovation costs. The investment is considered profitable if the NPV is positive, and unprofitable if it is not.

How much renovation would be profitable for private individuals without public support?

Estimated stock of housing

Figure 2 illustrates the scale of the cost-effective potential for renovation at BBC level, estimated using the method described above. It assumes that the BBC level is achieved by a combination of insulation and replacement of fossil fuel heating systems with a heat pump.[16]

[10] Aja P.-R., Ouadi L., Péron M. (2024): *op.cit*.

[11] Enertech-Perf in Mind (2021): *Multi-criteria analysis of energy-efficient renovations to single-family homes*.

[12] Laprie V., Voia A., Giraudet L.-G. (2024) : Moral hazard in the quality of building energyefficiency: Evidence from post-retrofit audits.

[13] Christensen P., Francisco P., Myers E. and Souza M. (2023): "Decomposing the wedge between projected and realised returns in energy efficiency programs", *The Review of Economics and Statistics* no. 105 (4), pp. 798-817.

[14] See European Commission, Directorate-General for Energy (2013): Energy performance certificates in buildings and their impact on transaction prices and rents in selected EU countries, 19 April; Civel E. (2020): Capitalization of energy labels versus Techno-economic assessment of energy renovations in the French housing market.

[15] Giraudet L.-G. (2020): "Energy efficiency as a credence good: A review of informational barriers to energy savings in the building sector", *Energy Economics* 87, 104698.

[16] It should be noted that the legal constraints that stand in the way of the widespread use of heat pumps, in particular architectural regulations and problems of noise pollution in condominiums, are not taken into account in the modelling.

Box 1. Modelling home energy renovations

Giraudet and Vivier ("Analyse socio-économique de la rénovation énergétique des logements", Focus no. 106, June 2024) use detailed data on the performance of the housing stock, the cost of the various renovation measures and the characteristics of the occupants to estimate the private and social profitability of energy renovation in France. The estimate is based on 180,000 archetypes associating dwellings and the households that occupy and/or own them, segmented by type of dwelling (individual or collective), heating system, level of insulation of the floor, roof, walls and windows, occupancy status (owner-occupier, private rental, social rental), income of the occupying and/or owning household. The analysis takes into account market failures, behavioural effects and social benefits. Renovations are modelled as combinations of actions specific to each dwelling, enabling it to achieve the BBC standard, in line with the government's commitments in terms of energy renovation. The study is based on the following methodological choices:

- Renovation costs are modelled as the sum of technical costs and financing costs. Technical costs vary according to the actions taken, assuming that they are perfectly coordinated. The financing cost corresponds to an annual interest rate of 3.9% over ten years.
- For households, the benefits taken into account are the energy savings on bills and the gains in comfort. Based on estimates in the literature, actual savings are estimated at 60% of the theoretical savings predicted, while comfort gains represent an additional 10%.
- The discount rate used in the main scenario is the 3.2% rate recommended for the valuation of public investments.[a] Private and social benefits are evaluated for the next 25 years. In the main scenario used for modelling the Note, energy prices are current prices considered to be constant, minimising expected benefits (conservative assumption) given the upward trends observed over the recent period.[b]
- The social benefits in terms of CO_2 emissions are estimated on the basis of a social carbon price of €200/tonne of CO_2, the value recommended in France by the Quinet report for current investments.[c] This is a conservative assumption, insofar as the report mentions that the social cost of carbon will rise to €775/tonne of CO_2 in 2050 in order to meet carbon neutrality targets.
- As for the social benefits linked to health gains, it is assumed that the health externalities of energy renovation only need to be taken into account for the 30% of households with the lowest incomes. On this assumption, in the case of renovating low-energy homes, they are estimated at €7,500 per accommodation.[d]

These modelling choices best reflect current knowledge of household behaviour and the costs and benefits of renovation. Sensitivity analyses and a discussion of potential biases confirm the robustness of the results. However, it should be emphasized that there is very little research available to study determinants and consequences of renovation decisions in France.

[a] France Stratégie (2022): Taux d'actualisation : un bêta sensible, Infographie, November.

[b] For the more recent period, see Ministère de la transition écologique et de la cohésion des territoires : Conjoncture énergétique (first quarter 2024) and, for a longer-term vision, the Ademe forward-looking report Transition(s) 2050.

[c] Quinet A. (2019): La valeur de l'action pour le climat, report for France Stratégie.

[d] Dervaux B. et al. (2022): L'évaluation socio-économique des effets de santé des projets d'investissement public, report for France Stratégie.

According to the figure, in the absence of any public support, BBC renovations are cost-effective for 26% of the main dwelling stock (light blue), representing a reduction in GHG emissions of around 28% compared to 2018.

Barriers limiting the scale of private renovation

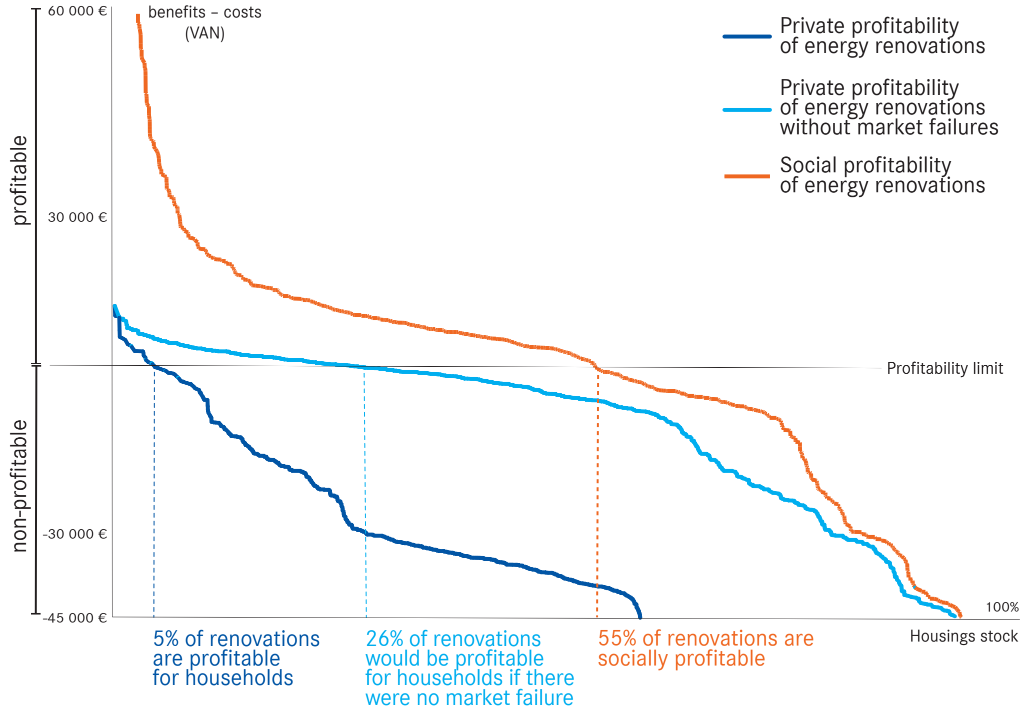
Actually, there are a number of barriers to profitable investment. First, households tend to value future benefits less than public authorities. The economic literature shows that the rate of pure preference for the present declines with income, averaging 8%, which is to be compared with the 3.2% rate recommended for evaluating public investment. This lower weighting of future benefits reduces the private value of investment.

Private investment is also hampered by rationing problems in the credit market. Banks, unable to monitor households' creditworthiness perfectly, tend to deny them credit if the annual repayments represent an excessive proportion of their income. These credit constraints limit the proportion of households that can finance the work, thereby reducing the number of profitable renovations.

Finally, there are two problems specific to the housing market that contribute to limiting investment in energy efficiency renovations:

- In rental housing, the ability to pass on the cost of renovation work to tenants is limited by various regulations, particularly in areas where rents are low or subject to rent controls. Renovations can also involve non-monetary costs if the landlord has to offer a solution

Figure 2. Private and social profitability of the renovation of the entire housing stock (net present value)



Source: Giraudet L.-G. et Vivier L. (2024): « Analyse socio-économique de la rénovation énergétique des logements », *Focus* no. 106, June.

for rehousing the tenant or wait until the property is vacant before starting the work.[17]

- In collective housing, investment decisions are subject to coordination problems. Decisions that are the responsibility of the co-owners (such as external insulation) are hindered by a distribution of individual contributions that is not necessarily proportional to the distribution of individual benefits. Decisions that are not the responsibility of co-owners (such as internal insulation) are hampered by externalities when two adjacent dwellings are subject to heat transfer.

When these various barriers are taken into account, the proportion of renovations that would be feasible and profitable for households in the absence of public intervention falls from 26% to 5% of the housing stock, as shown in Figure 2. Barriers to investment therefore have a very clear impact on the private profitability of renovation. They require targeted public intervention.

Finding 1. Without market failure, the share of privately profitable renovations corresponds to 26% of the housing stock. If the numerous market failures on the renovation market are included, this figure falls to 5%.

What are the social benefits of renovation?

In addition to the private benefits to households, energy efficiency renovations generate social benefits in the form of reduced CO_2 emissions and improved health. Taking these benefits into account increases the share of socially profitable renovations. Some of these renovations have a negative private rate of return and should be actively promoted by public intervention. In order to determine the level of public support required, it is important to quantify the social benefits as accurately as possible.[18]

[17] During the term of the lease, an upward revision following renovation work is only possible if there is a prior agreement between the tenant and the landlord. When renewing a lease, rent reviews are regulated in areas where the property is under pressure, and the scope for rent increases following renovation work is limited. In tense areas, rent rises may not exceed 15% of the cost of the works or 50% of the difference between the old rent and comparable rents in the geographical area. What's more, in areas subject to rent control, rents may not exceed a certain increased rent (+20% of the benchmark rent in Paris). So, in theory, the rent on a property that is already at the ceiling cannot be increased after renovation in a city like Paris.

[18] However, the work also generates so-called "grey" emissions, which can account for up to a third of the emissions avoided.

Social benefits of energy renovation

Environmental benefits

Reducing heating demand by improving insulation and replacing fuel-based heating systems with heat pumps will reduce CO_2 emissions. These cumulative and discounted gains amount to an average of 30 TCO_2eq per renovated home, or three years of average emissions for a French person. The gains are five times higher for heating oil homes than for electric homes. Valuing these benefits at the social value of carbon helps to increase the profitability of renovations compared to the private benchmark.

Health effects

Energy efficiency renovations also have a positive impact on the health of the occupants and therefore on society as a whole. Poorly insulated homes expose their occupants to low temperatures, which can lead to cardiovascular and respiratory diseases. Long ignored, these "health costs" have recently been assessed by France Stratégie.[19] They include care costs, morbidity costs for loss of wellbeing due to illness, and mortality costs for extreme cases (estimated at 3%) where illness leads to death. While care expenditure is clearly a social cost in the context of the mutualisation of health care that prevails in France, the status of morbidity and mortality is more ambiguous from a conceptual point of view. Socio-economic analyses generally assume that the wealthiest households have the means to protect themselves from cold-related morbidity.

Socio-economic analyses generally assume that the wealthiest households have the means to protect themselves from cold-related morbidity (and ultimately mortality), but that the most financially constrained households do not. From this perspective, health effects are considered as externalities to be internalised by public authorities when they affect households in the first three deciles.[20]

Which renovations are socially profitable?

While 26% of renovations are profitable from a private point of view, socially profitable renovations amount to 55% of the housing stock, or around 15 million dwellings (Figure 2). For 45% of the housing stock, the costs of renovation are higher than the benefits, including social benefits, using current parameters. Renovating 55% of the housing stock would reduce CO_2 emissions by around 70% compared to 2018 levels. Although significant, this reduction is not enough to achieve carbon neutrality, assuming a constant energy production system.

Finding 2. Taking into account the social value of avoided emissions and the health costs associated with exposure to cold, and assuming that barriers to investment are removed, the share of socially profitable retrofits amounts to 55% of the housing stock, reducing CO_2 emissions by 70%.

In additional modelling detailed in *Focus*,[21] a social carbon value of €500/t CO_2 increases the proportion of socially profitable renovations from 55% to 65%, i.e. almost 3 million additional dwellings, and the proportion of CO_2 emissions avoided rises to 82%.

Increasing the share of renovated dwellings from the privately optimal level (26%) to the socially optimal level (55%) requires an estimated total subsidy volume of €2-3 billion per year until 2050. However, if the private reference includes investment barriers (with only 5% of profitable renovations), this figure rises to 6 billion per year.

These estimates call for three comments. Firstly, this calculation assumes that the subsidy is the instrument that overcomes all barriers to investment. This assumption seems valid for making credit available to credit-constrained households, for encouraging co-owners to coordinate their efforts, and for overcoming the undervaluation of future profits. It seems less appropriate for eliminating frictions between owners and tenants, some of which are regulatory.

Moreover, this figure is based on the assumption that the house/household pairs for which renovation is socially profitable but not privately profitable are perfectly identified. In practice, such precise identification is impossible, and the targeting approach demands an effort of identification and support, which entails additional costs.

Similarly, this figure does not take into account the funding required to address the quality deficiencies that limit the effectiveness of the renovations. Finally, it should be remembered that this costing does not make it possible to achieve carbon neutrality without investment in decarbonising the energy sector.

From a more realistic perspective, where the renovations to be supported cannot be perfectly identified, we try to determine whether the observable characteristics still make it possible to target them effectively. Table 1 shows the distribution

[19] Dervaux et al (2022): L'évaluation socio-économique des effets de santé des projets d'investissement public, report for France Stratégie.

[20] These estimates, the best currently available, are methodologically limited by the lack of longitudinal monitoring of housing conditions and household health. In addition, other less well-documented health effects, such as pollution linked to heating methods (wood burning in particular) and exposure to heat waves, are likely to be avoided by improved energy performance.

Table 1. Share of the housing for which renovation is socially profitable but not privately profitable

Housing characteristics		
Energy performance	DPE C	18%
	DPE D	33%
	DPE E, F, G	49%
Energy vector	Gas	63%
	Electricity	20%
	Fuel oil	16%
	Others	1%
Housing type	individual housing	35%
	collective housing	65%

Targeted household characteristics			
Status	Social rental	23%	
	Private rental	31%	
	Ownership	45%	
Income		occupants	owners
	Q1	24%	8%
	Q2	21%	12%
	Q3	18%	12%
	Q4	18%	17%
	Q5	18%	52%

Reading: Among homes where renovation is profitable for society but not for households, 45% are owner-occupied and 31% are rented. 52% of the owners of these homes belong to the last quintile of this income (20% of the most affluent) and 24% are occupied by households belonging to the 1st quintile (20% of the least affluent).

Source: Giraudet L.-G. et Vivier L. (2024): *op. cit.*

of observable characteristics of renovations that are profitable for society but not for the homeowner. It is clear that half of these dwellings are heat sieves (classified as E, F or G) and the majority (79%) are heated with gas or oil.

The distribution of characteristics of occupied and/or owner-occupied households is more uniform and offers fewer opportunities for targeting. It shows that, beyond the evidence on thermal housing and fossil fuels, it is difficult to use easily observable criteria to target subsidies to specific types of households. However, renovating heat sieves has a very clear impact on fuel poverty, with co-benefits in terms of health that justify subsidising it generously and as a priority. For other households, a specific audit, for example through the MonAccompagnateurRénov', seems necessary to identify the households to be subsidised.

Finding 3. Priority should be given to the renovation of lowest energy performance dwellings and dwellings using fossil fuels for heating.

Thus, there is considerable room for manoeuvre for energy-efficient housing renovation to contribute more effectively to carbon neutrality and social wellbeing.

Is current public policy effective?

The identification of numerous barriers to investment justifies a wide range of public policies to support energy renovation. In practice, the instruments used are many and varied. Currently, subsidies are the preferred tool, with four schemes: the MaPrimeRénov' scheme, zero-interest eco-loans (EPTZ), reduced VAT and bonuses linked to energy performance certificates (CEE). Are these instruments effective in achieving their objectives?[22]

The available evaluations show a positive effect of public support schemes on both the likelihood of investing and the amount invested. The combination of these effects means that one euro of public support generates more than one euro of additional private investment,[23] i.e. a leverage effect of more than 1.[24] The zero-interest eco-loan (EPTZ) initially had a leverage effect of 1.5, mainly due to its particularly strong impact on the investment decisions of low-income homeowners. However, the reluctance of banks to provide this type of loan has reduced its effectiveness.[25]

Overall, the leverage effect of subsidies increases when they are targeted at low-income households and/or large-scale renovations. In this respect, the benefits of reduced VAT, which is essentially non-targeted unless it excludes second homes, are limited.[26] On the other hand, the efforts to improve

[21] Giraudet L.-G., Vivier L. (2024): Focus no. 106, op. cit.

[22] For a detailed presentation of public intervention schemes, a discussion of their theoretical justification and studies of their effectiveness, see Giraudet L.-G. (2024): "Efficacité et effets distributifs des politiques de rénovation énergétique", CAE, *Focus* no. 107, June.

[23] Chlond B., Gavard C. and Jeuck L. (2023): "How to support residential energy conservation cost-effectively? An analysis of public financial schemes in France", *Environmental and Resource Economics*, 85(1), pp. 29-63; Giraudet L.-G., Bourgeois C., Quirion P. (2021): "Policies for low-carbon and affordable home heating: A French outlook", *Energy Policy* 151, 112140.

[24] Nauleau M.L. (2014): "Free-riding on tax credits for home insulation in France: An econometric assessment using panel data", Energy Economics, 46, pp. 78-92; Risch A. (2020): "Are environmental fiscal incentives effective in inducing energy-saving renovations? An econometric evaluation of the French energy tax credit", Energy Economics 90, 104831.

[25] Eryzhenskiy I., Giraudet L.-G. and Segu, M. (2023): Success and Failure of a Zero-Interest Green Loan Program: Evidence from France.

[26] Cour des Comptes (2023): *Le soutien aux logements face aux évolutions climatiques et au vieillissement de la population*.

targeting that accompanied the transformation of the CITE into the MPR should be highlighted. However, the low number of efficient renovations carried out in recent years suggests that it is still insufficient.

The CEE premiums, a special type of subsidy, are the result of an energy saving obligation imposed on suppliers. Each premium distributed gives entitlement to energy certificates that can be exchanged between suppliers, for them to meet their obligation in the most cost-effective way. In the context of liberalised energy markets, energy suppliers can pass on the cost of the premiums in their energy prices. CEEs have been the subject of very few evaluations due to the private nature of the data. They appear to be a well-targeted subsidy, thanks to a system of bonuses for low-income households ("precariousness CEE") and heating and insulation "boosts". The former limit the anti-distributive effects of the scheme (which leads to an increase in energy prices for all households when only a minority benefit from the bonuses) and the latter have effectively stimulated the supply of renovations.[27] However, these provisions are the result of public decisions rather than an active strategy on the part of energy suppliers. They cast serious doubt on the hypothesis that energy suppliers have an information rent on the most profitable sources of energy savings that the scheme would allow them to exploit.

On the other hand, they are similar to government intervention in the EWC price, which undermines the market-based nature of the scheme. Under these conditions, the added value of the market mechanism compared to a public subsidy programme seems very limited.

Finally, it should be noted that there has been very little evaluation of the actual energy savings associated with the various subsidy schemes. The only evaluation available so far concludes that there is a gap of 50% between actual savings and those predicted by the CEE packages, an order of magnitude similar to the gap between actual and theoretical energy savings mentioned above.[28]

In general, incentive instruments provide visibility on public expenditure but not on environmental performance. The delay in meeting environmental targets has recently led to a shift in the public debate towards regulatory instruments. The ban on the rental of heat sieves is a response to the inability of subsidy programmes to remove the barriers specific to the rental sector. The ban will be enforced from 1 January 2023 on dwellings classified as G+, and will be extended to all G dwellings in 2025, then to F dwellings in 2028 and to E dwellings in 2034.The early announcement of this timetable is intended to encourage landlords to renovate their properties and improve their energy efficiency. However, the effectiveness of such a measure depends on the dynamics of the property market, as landlords may prefer to put their properties up for sale rather than renovating them, thereby contributing to a reduction in the supply of rental properties. These effects will need to be rigorously assessed as the scheme is rolled out.

Finally, the management of the whole energy renovation policy relies on the information provided by the Energy Performance Diagnostic (EPD), a tool that is constantly evolving and subject to much criticism. Box 2 provides an update on the degree of reliability of this tool, which is developing favourably but does not meet all the challenges.

Box 2. Is the indicator DPE reliable?

The Energy Performance Diagnostic has become an essential tool in the property market, measuring the energy performance of housing stock and serving as a compass for renovation policies. So it's vital that it's reliable and that the information it provides is well understood. However, it has come in for a lot of criticism. It can be manipulated because it is based on a model that is sensitive to the parameters set by the diagnostician. Theoretical consumption figures do not reflect actual consumption. The study by Aja et al (2024)[a] examined the ability of the DPE to reflect the theoretical energy consumption of a dwelling. It reveals an abnormal concentration of DPEs at the favourable limit (within a few kWh) of the D, E and F labels in particular, confirming suspicions of manipulation. By observing this manipulation before and after the DPE reforms in 2021, the study shows that the generalisation and improvement of the 3CL model has helped to reduce the proportion of "suspect" DPEs from 3.2% to 1.7%.

The study by Astier et al.[b] looks at the ability of the DPE to reflect actual energy consumption. Using bank data (Crédit Mutuel), it reveals a gap between theoretical and actual consumption ranging from 20% for A homes to 70% for G homes. This difference can be explained by the fact that the less efficient the home, the greater the restriction on consumption.

[a] Aja P.-R., Ouadi L., Péron M. (2024): "Améliorer la fiabilité du DPE :une évaluation des réformes de 2021", Focus no. 105, June.

[b] Astier et al (2024): "Performance énergétique du logement et consommation d'énergie: les enseignements des données bancaires", Focus no. 103, January.

[27] Cohen F., Khan V., Wald G (2024): "Making Jobs Out of the Energy Transition: Evidence from the French Energy Efficiency Obligations Scheme", *Working Papers* 2024/01, Institut d'Economia de Barcelona (IEB); Darmais A., Glachant M., Kahn V. (2022): Evaluation des effets distributifs des certificats d'économies d'énergie dans le secteur résidentiel.

[28] Wald G., Glachant M. (2023): "The Effect of Energy Efficiency Obligations on Residential Energy Use: Empirical Evidence from France".

Consolidation and reallocation of renovation aid

Three lessons can be drawn from the herein above analyses. First, the housing stock for socially profitable energy renovation is considerable. However, it is not evenly distributed, and outside of classes F and G, it is difficult to target renovation opportunities on the basis of observable characteristics of dwelling-household pairs alone. Finally, the current policy mix is not delivering the expected results. There are still too few high-performance renovations, their quality is unproven, and they are triggered only after an uncertain and rocky path. We recommend renovation subsidies be to be consolidated and redirected to improve their effectiveness and achieve ambitious environmental goals.

Ring-fencing the financing of the project of the century

While the renovation of 55% of the housing stock would appear to be profitable from a social point of view, only 5% would be profitable from a private point of view, once the many barriers to investment are taken into account. Closing this gap with subsidies will require resources that we estimate at €150 billion, or €6 billion per year between 2025 and 2050.This figure represents a lower bound on the real needs. It indicates the possibilities for renovation, assuming perfect targeting. In practice, targeting can only be imperfect and is in any case costly, as it requires the use of consultancy services such as MonAccompagnateurRénov'.

Furthermore, this estimate doesn't include the cost of essential quality controls. Finally, the needs are assessed using a social carbon value of €200/TCO_2eq,[29] which is still well below the value that would make it possible to achieve carbon neutrality for domestic heating. At a carbon value of €500/TCO_2eq, the 3 million additional homes to be renovated would increase the annual funding requirement by more than 50%. We therefore believe that it is essential to maintain the current budget for energy renovation in the private sector, which amounts to €8 billion if we add the MPR, the reduced VAT rate of 5.5%, the EPTZ and the CEE[30], as well as local aid that is not counted annually.[31] As far as public authorities are concerned, the government must make its actions more transparent by committing itself to multi-annual budgets based on stabilised aid scales.

Recommendation 1. Maintaining the budget for energy renovation by committing to a multi-annual budget of around €8 billion per year.

In a tight budgetary context, securing such an effort will require a combination of public funding - from the state and local authorities - and private funding - from energy suppliers through the CEE and from banks through the EPTZ. Major adjustments are needed. The main one concerns the CEE scheme, which has not proven its added value compared to a public subsidy scheme. We propose to replace it with a "general contribution to the public energy efficiency service" from energy suppliers, which would be added to the overall MaPrimeRénov budget. As CEEs are already financed by distributors and therefore included in the energy price, this change should not have an inflationary effect. It would also simplify the support system, which would be based solely on MaPrimeRénov' subsidies, and make it more transparent, thereby improving its efficiency.

Recommendation 2. Replace the CEE scheme with a contribution funding directly the MaPrimeRénov' budget.

Targeting demand through an active approach

A significant proportion of public funding should be channelled through a system of targeted subsidies. The priority for public action should be to renovate the 5 million dwellings classified as F and G to BBC standards. Targeting the most run-down dwellings by modulating subsidies according to the income of the occupants makes it possible to improve the efficiency of public spending while reducing fuel poverty and its associated health effects. In this respect, the differentiation of support according to income levels in the MPR and CEE schemes is welcome. The emphasis on high performance renovations, as considered in the new version of the MPR, which was abandoned in March 2024, needs to be maintained.

In addition, achieving carbon neutrality in heating is impossible without the widespread use of low-carbon heating sources.

It is therefore essential to support this transition with incentives to combine insulation measures with changes in heating systems. Regular evaluation of the effectiveness of subsidies should make it possible to assess whether an incentive policy is sufficient to achieve the objectives or whether it should

[29] At the global level, the social values of carbon are constantly being revised upwards (Tol, R.S.J. (2023): "Social cost of carbon estimates have increased over time ", *Nat. Clim. Chang.* 13, pp. 532-536). A recent estimate, which takes better account of the geographically heterogeneous effects of temperature rises, even puts it at 1,056 dollars per tonne of CO_2 : Bilal A., Känzig D.R., (2024): "The Macroeconomic Impact of Climate Change: Global vs. Local Temperature", *Working Paper Series*.

[30] See "Effort financier de l'État en faveur de la rénovation énergétique des bâtiments", appendix to the PLF 2024.

[31] Anil is providing a list of local subsidies, which will be updated at the end of 2024.

be combined with a ban on the installation of new fuel-fired heating systems, as is already the case for heating oil boilers.

Recommendation 3. Provide subsidies for renovations that combine insulation and conversion to a low-carbon heating system, and specifically target heat sieves by modulating subsidies according to the income of homeowners and occupants.

However, heat sieves represent only half of the housing stock to be renovated, and the observable characteristics of housing make it impossible to effectively target the other half. Overcoming this difficulty requires a paradigm shift. The dominant approach to date has been to open windows of assistance and leave the initiative for renovation to households, with possible support from energy suppliers to identify the most profitable interventions. Recognising the failure of this approach, we propose that public authorities take responsibility for identifying homes in need of renovation and experiment with an approach that actively targets their owners. This change requires the creation of a strategic pillar within France Rénov to consolidate existing databases and invent artificial intelligence tools to develop operational targeting criteria. At the same time, the MonAccompagnateurRénov system must be strengthened in order to validate targeting through a grassroots approach. The involvement of local authorities is essential to identify opportunities for neighbourhood-scale renovation, which will generate economies of scale. This paradigm shift would allow the planning State to return to the major infrastructure programmes that gave individuals access to many public services, such as telecommunications and sanitation, in the last century.

It would also have the added benefit of restoring the State's control over spending, thus avoiding the problems of underspending.

Recommendation 4. Establish a strategic pillar within France Rénov to identify dwellings in need of renovation and experiment with an active targeting approach by "reaching out" to their owners.

Renovation opportunities also need to be targeted over time by focusing on the most opportune time to renovate a home: when the owner changes. To this end, we propose an incentive mechanism that would make this renovation opportunity more salient for both the seller and the buyer. The proposal is to levy a surcharge on the transfer tax (DMTO) for, for example, homes rated F or G – which would be refunded to the buyer if he or she undertakes major renovation work within two years of purchase. We expect this measure to have two effects: from the seller's perspective, it should lead to a reduction in the value of the homes concerned, which could create an incentive to renovate in order to maintain the attractiveness of the property. From the buyer's point of view, if the property was not renovated prior to the sale, the low purchase price and the prospect of reimbursement of the additional DMTO paid will encourage them to undertake the work himself. In both cases, the transfer of the property is an ideal time to provide information and assistance to the households concerned. If no renovation is undertaken, the DMTO surcharge can be used to fund strategic assistance programmes at local level.

Recommendation 5. Modulate the DMTO according to the energy performance of the property, with the buyer being refunded the additional cost if the property is subsequently renovated.

Structuring the supply

The low availability of certified quality products is also a major bottleneck for energy renovation. Difficulties accumulate all along the value chain. Upstream of the project, the prescription for work is based either on the very limited recommendations of the DPE or on a more reliable but more expensive energy audit. At the beginning of the project, it is difficult for households to find a trustworthy company.

While the RGE label creates a register that facilitates the search phase, it also creates barriers to entry that are a source of potential inflationary effects.

Moreover, it only provides an ex-ante guarantee of the quality of the work. In the absence of intensive monitoring, it does little to protect households from quality defects, which generally only become apparent after the project has been completed. The announcements made in March 2024 to simplify the granting of the RGE label are a step in the right direction, in particular the extension of the period of validity from 4 to 8 years and the access to the label through the validation of acquired experience based on the inspection of a completed construction site. It is important that these measures are implemented quickly and that they are even extended, for example by allowing the label to be awarded to a company where an employee has the necessary training validated by a diploma obtained as part of his or her initial training. At the same time, in order to improve the quality of renovations and provide guarantees for households, we recommend strengthening ex-post controls, which would be carried out intensively and managed by a public service rather than by companies, as is currently the case. Even if ex-ante energy audits and ex-post controls add to the cost of renovation, simplifying the procedures for RGE labelling would reduce the barriers to entry into the renovation sector and could have a moderating effect on prices while strengthening incentives for quality. Stricter controls would also make it possible to limit repair costs in the event of poor workmanship and to combat fraudulent practices. Finally, given that poor quality is not only the result of opportunistic behaviour, but more fundamentally of a lack of skills, it is essential to consolidate professional training efforts and to monitor an open data system with all certified information on renovation professionals: ten-year guarantee, MonAccompagnateurRénov.

Recommendation 6. Simplify the granting of the RGE label while creating a public authority for ex-post quality control by increasing penalties in the event of proven quality shortcomings.

Consolidating official statistics to improve policy implementation

The government must continue its efforts to consolidate and open up existing databases, which began with the creation of the National Energy Renovation Observatory.

These efforts should focus on enriching and matching four types of data: the thermal and socio-economic characteristics of the housing stock, renovation flows (including unsubsidized renovation flows that escape public statistics), energy consumption data, and economic data on construction companies and property transactions. In order to better monitor the long-term impact of renovations, these data could also be matched with more detailed information on thermal comfort and household health using a sub-sample. Recent progress, such as the creation of the National Building Database and the forthcoming matching of energy renovation data with energy consumption data by the Statistical Data and Studies Department, is to be welcomed. However, what remains to be done is to make the approach more permanent through longitudinal monitoring of households and dwellings over a large sample. The cornerstone of this system would be to give each dwelling a statistical identity describing its thermal performance and its evolution over time.

Recommendation 7. Collecting regularly data on energy efficiency and renovation and link it to other socio-economic and energy consumption data to support a statistical register of dwellings.

At the same time, we need to broaden our efforts to evaluate public policies, in particular by giving researchers access to more detailed data on EWCs and by systematically identifying local aid, which has a potentially crucial role to play but remains a blind spot in the evaluation process.

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