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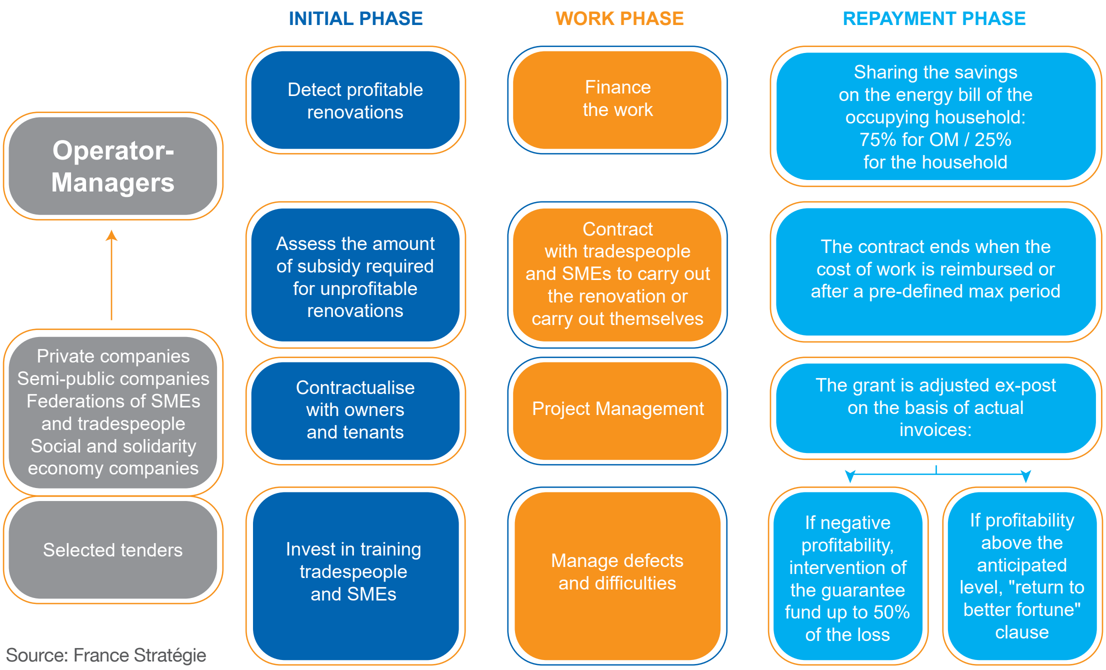
How to scale up home energy retrofits

The French recovery plan provides substantial additional public financing for energy-saving home improvements. In order to meet the objectives in terms of the number of energy retrofits, this policy brief proposes a mechanism to remove the main obstacles[1]. Energy retrofit operators (ERO) would finance and carry out the retrofit operations. They would be reimbursed by sharing the savings made on the energy bill with the owner-occupier or the tenant (with a 75%/25% split). A public guarantee would partially cover the operator's loss when the operations turn not profitable. Households would not need to advance any costs, nor bear any risk related to defects and project management. The operators benefiting from the public guarantee would be selected by public tendering and a quality label would help increase visibility and trust among the general public.

By strengthening the current third-party financing and energy performance contract schemes, the scheme would make it possible to target retrofits offering the best self-financing rate for an ambitious level of renovation. It would also optimise public aid by limiting it to the strictly necessary, largely thanks to a financial recovery clause. €7.5 billion of additional activity could be generated each year, i.e. 0.3 GDP points and 100,000 new jobs. At full capacity, the scheme would help reduce the country's CO_2 emissions by 2.4%. The scheme could be adapted to public or corporate buildings and deployed in territories or districts in the form of "concerted renovation zones", in coordination with local authorities. Good incentives would guarantee simple and inexpensive administrative management of the scheme.

Sustained low energy prices will continue to hamper the implementation of renovation work. In order to compensate for the resulting drop in profitability, clauses may be included that provide for a longer amortisation period and a lower level of energy savings passed on to households. In all cases, fuel oil should be excluded from post-renovation energy sources, in line with the objective of carbon neutrality by 2050.

Diagram 1 – The three phases of energy renovation according to the new system



Source: France Stratégie

1. For a detailed version, refer to the associated document: Aussilloux V. and Baïz A. (2020), "Accroître l'investissement dans la rénovation énergétique des logements du parc privé", *Document de travail*, n° 2020-14, France Stratégie, September.

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INCREASING ENERGY RETROFITS TO MEET FRANCE'S CO_2 TARGETS

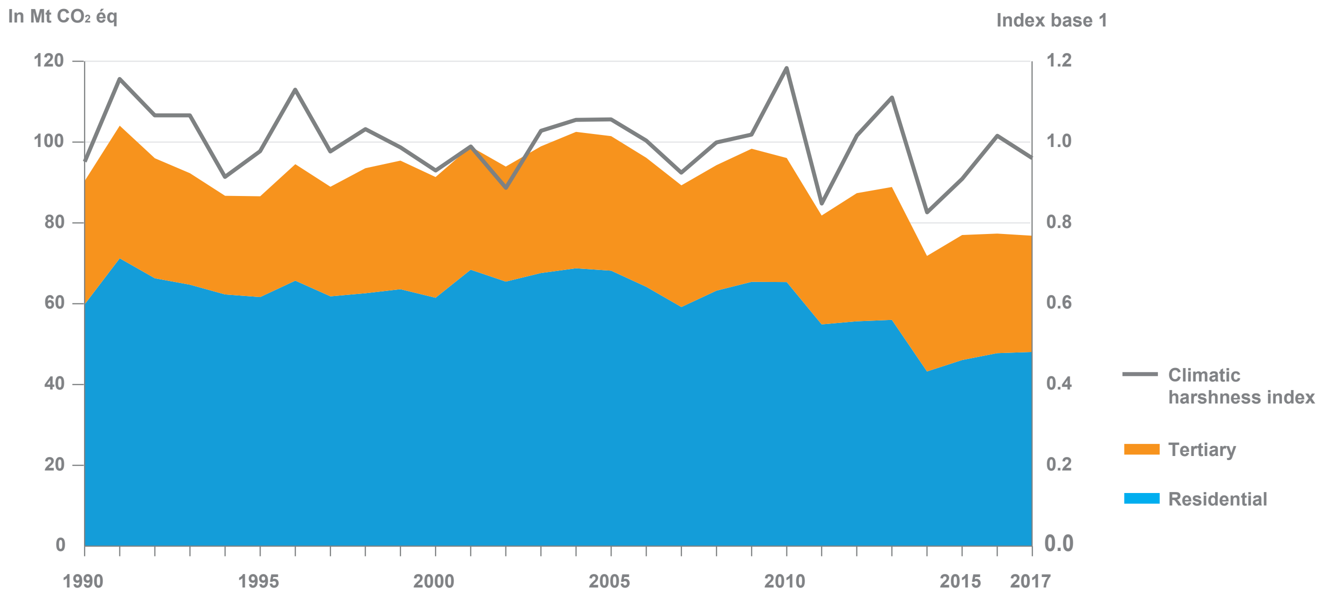
The residential and tertiary sector is responsible for 20% of national greenhouse gas emissions, 12% of which comes from the housing sector alone[2]. This total rises to 25% when indirect emissions from energy and heat production are taken into account. Greenhouse gas emissions from buildings mainly come from heating (over 80%), cooking and domestic hot water, for which gas and fuel oil are significant sources of energy (60% and 33% respectively).

Every year, considerable public resources are allocated to the energy retrofit of buildings. In 2019, the State spent nearly €3.9 billion, mainly on tax credits and tax breaks. To this, one can add aid from local authorities, pension funds and Action logement. In total, in line with the Sustainable Building Plan, €4-5 billion of aid is mobilised annually for the private sector[3].

Despite this high level of public commitment, the investment deficit remains worrying: in 2017, emissions from existing buildings were 22% higher than the budget set in the first National Low Carbon Strategy (*Stratégie nationale bas carbone or SNBC*). This is mainly due to a shortfall in energy-efficient renovations. However, in 2050 70% of building stock will still consist of constructions built before 2012. Successful thermal retrofit of existing buildings is therefore essential if France is to achieve carbon neutrality by that date.

The additional investment in the thermal renovation of private housing in France needed to achieve a descending path compatible with the objectives amounts to between €4.5 billion (low estimate) and €8 billion (high estimate) annually over the period 2019-2028[4]. The "energy retrofit of buildings" plan adopted in April 2018 aims to almost double the rate of renovation to reach 500,000 renovated housing units per year by 2025[5]. The Energy Transition Law for Green Growth (LTECV) also sets a longer-term objective of making the entire stock "low energy housing"[6] by 2050. To achieve this, energy retrofits will need to further gather pace to reach at least 700,000 complete renovations per year. The Citizen's Assembly on Climate even recommends enforcing a comprehensive energy retrofit on all buildings by 2040, which means an average one million housing units per year. The Recovery Plan announced by the government provides an additional €6.7 billion of public money for the energy retrofit of buildings: €4 billion to be spent on public buildings, €500 million on social housing, €200 million on energy improvements in the buildings of small and very small businesses and €2 billion on private housing stock.

Graph 1 – Greenhouse gas emissions from the residential and tertiary sector in France



Source: SDES, *Key Climate Figures* (2020)

2. See "Les émissions de GES du secteur résidentiel-tertiaire", on the Ministry of Ecological and Solidarity Transition website.
3. Plan Bâtiment Durable (2019), *Parc privé locatif et rénovation énergétique - 10 propositions pour l'éradication des logements énergivores*, October.
4. Cochran I., Hainaut H. and Ledez M. (2018), *Panorama des financementsclimat2018*, I4CE.
5. Document available on the Ministry of Ecological Transition website.
6. The Bâtiment basse consommation (BBC) label was created by the decree of 8 May 2007. It requires existing buildings to consume at least half the energy required by the RT2005 thermal regulations.

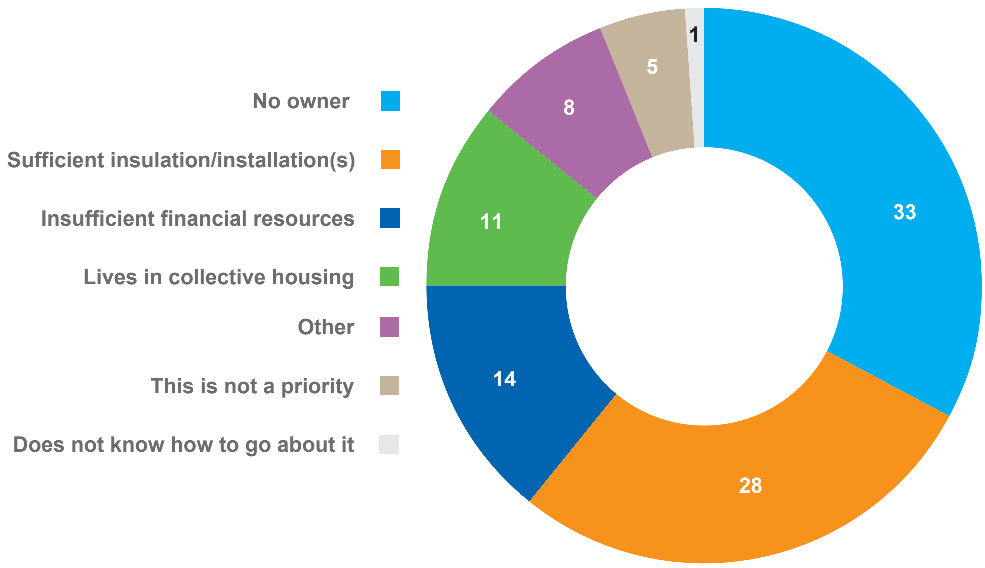
Targeting the most profitable thermal retrofits first

Since the 1970s, the academic literature[7] has reported various obstacles that explain why some energy-saving operations are not carried out, while others are profitable, i.e. they could generate savings on the energy bill greater than the costs of renovation. According to the French Treasury Department[8], 5 to 9 million housing units, i.e. between 14% and 25% of the total housing stock in France, could be the object of energy-saving operations that are financially profitable without public aid, without an increase in the carbon tax and even without taking into account the associated environmental and social benefits. According to the French Environment and Energy Management Agency (Ademe), the potential for energy savings that is both technically feasible and economically viable in the residential sector amounts to 19.2 TWh per year[9], i.e. 4% of the French residential sector's total energy consumption.

While these estimates are debated[10], the fact remains that the barriers to energy retrofit have been clearly identified. On the demand side, they are primarily informational, financial or cognitive, as illustrated by the results of a survey carried out by the MTES (graph 2). Above all, households are often unaware of the profitability of the thermal retrofit of their homes. They are dependent for their information on professionals in a sector that is still poorly structured and insufficiently trained in renovation.

They may be afraid to finance overpriced or poor quality renovations. They may also be unaware of the technical and financial support systems available, or fail to understand their sometimes complex workings (see Box 1). In this respect, only 15% of single-family households having carried out energy retrofit work benefited from information and support[11]. They are sensitive to the cost of the work and may also be risk-averse, preferring the *status quo*, especially given the imponderables that often arise during the work. Moreover, the timeframe within which the operations become profitable, if indeed they do at all, is sometimes distant, bearing in mind that many homeowner households are elderly. Moreover, any positive impact on the property's value is largely dependent on local property market characteristics. There are also many obstacles when it comes to obtaining agreement on heavy expenditure from the absolute majority in a private jointly owned property, or when it comes to motivating an owner-landlord who has to bear the costs of the energy retrofit of the dwelling while it is often the tenant who benefits from savings on the energy bill[12].

Graph 2 – Reasons given by individuals for not considering improvements to their insulation or heating system



Note: the question asked was "Why are you not planning to improve your heating system and/or the insulation of your dwelling?"

Source: Survey on the reasons for not considering improvements to insulation or the heating system in 2016 – Ministry of Ecological and Solidarity Transition 2017

7. Jaffe A.B., Newell R.G. et Stavins R.N. (2004), "Economics of energy efficiency. 79-90 in Cleveland", C.J. (ed), *Encyclopedia of Energy*, volume 2, San Diego and Oxford (UK): Elsevier.
8. Camilier-Cortal I., Loublier A., Perrot E. and Souletie A. (2017), "Barriers to investment in energy efficiency: which tools for which savings?" DG *Treasury Working Papers*, No. 2017/02, March.
9. Based on 1 TWh cumac = 0.0665 Twh and 1MTep = 11.63TWh. Ademe (2020), *Updating of the study of energy saving certificates 2021-2030* and CGDD (2019), *Bilan énergétique de la France 2017*.
10. See in particular Blaise G. and Blanchant M. (2019), "Quel est l'impact des travaux de rénovation énergétique logements sur la consommation d'énergie?", *La Revue de l'énergie*, No. 646.
11. Ademe (2018), TREMI survey. *Energy renovation work on single-family homes*, 2017 campaign, October.
12. Between a third and a half of the profitable deposit would be in rented accommodation.

A new system combining market mechanisms and public intervention

Given the urgency and the scale of the issues at stake, it is crucial to set up a system that tackles the main obstacles to energy retrofit, namely the lack of information on the profitability of operations, the lack of trust in the operators involved in renovation, and difficulties with funding work. To overcome these obstacles jointly and consistently – and therefore more effectively – this system uses several levers: a company labelling system, support and advice, third-party financing, energy performance contracts, and a public guarantee mechanism. Following interviews with many stakeholders in the field (third-party financing companies, renovation companies, public administrations, consulting firms, energy companies, etc.), the proposal is to select energy renovation operators who would take charge of financing renovation operations in full, mainly through energy savings. Should an operation turn out to be unprofitable, it would be partly covered by the public guarantee[13].

First of all, the public authority would issue a call for tenders to select the "operator-managers", prime contractors and funders of the energy retrofit works. This call for tenders would be based on technical, financial and organisational criteria: the operators would have to demonstrate their ability to identify the most profitable operations, guarantee the quality of the energy retrofit work, and enter into contracts with the renovation tradespeople and companies. Above all, they would have to put forward the total funds necessary for the work, to the benefit of the households having agreed to proceed with the energy-saving operation. In this role, we see private companies or public or quasi-public entities (semi-public companies), arms of large local authorities with good financial rating, existing third-party financing companies which could extend their role (see Box 1), and local building trade federations and SMEs supported by financial structures such as "green funds"[14].

Box 1 — An array of energy retrofit aid and support schemes

In France over the last twenty years, several dozen schemes have been set up to promote energy-saving operations. The financial schemes include the energy transition tax credit (CITE), which covers 30% of eligible expenditure on energy retrofit work. The Zero-rate Eco-loan (Éco-PTZ) can be used to finance energy retrofit work in housing at a zero interest rate. MaPrimeRénov' is a financial aid scheme aimed at the lowest-income households and can cover up to 50% of expenditure on energy retrofit work. In 2021, it will completely replace CITE and extended to all households. This kind of renovation work also benefits from a reduced VAT rate of 5.5%. Action Logement and the local authorities also provide aid.

The regulatory or contractual measures include thermal regulations requiring a minimum performance level for new buildings and for the renovation of residential and tertiary buildings. Energy performance contracts bind a project owner and an energy services provider to an energy performance target. Third-party financing means an external organisation uses the stream of income from the energy cost savings to repay the costs of the retrofit. When the owner and tenant share the cost savings, they can – under certain conditions – share the cost of the energy retrofit work. Informative operations such as "energy passports" establish an energy diagnosis of dwellings and suggest actions to improve their energy performance. In addition, platforms have been set up to improve training, advice and support for stakeholders (e.g. the energy efficiency public service, the FAIRE platform, etc.). Then there is a hybrid format, whereby a system of energy-saving certificates requires the main energy retailers (EDF, Total, Engie, etc.) to promote a certain number of energy-saving operations among their customers, or pay penalties to the State. To encourage households to undertake renovation work, energy retailers generally pay them bonuses, which can be combined with certain forms of public aid.

*To benefit from a particular scheme, the potential beneficiary must meet certain conditions (means testing, work to be done on the main home, etc.). In most cases, public aid is only possible if the work is carried out by a company with specific environmental certification (*Reconnue Garante de l'Environnement, or RGE*), and only applies below a certain spending limit, with documentary evidence required.*

13. The acceptable break-even point is defined ex ante by the regulator at the time the tender is launched. The public guarantee comes into play when profitability becomes negative, but other complementary mechanisms may be mobilised first in order to maintain the operation's profitability (see below).
14. Green funds finance companies whose activities have a positive environmental impact.

The selected operators would identify renovation operations on the basis of an energy performance diagnosis (ECD)[15] and taking into account their forecasts for future energy prices, the cost of the work and possible savings on the bill. The profitability calculation would also account for the various public subsidies that would be paid at the start of works. As with a third-party financing scheme, the operator would draw up a contract with the operation's beneficiaries, to ensure monthly payment based solely on the savings made on the energy bill over 10, 15 and up to 30 years. It may be possible to reserve 75% of the amounts saved on energy for the operator, and the rest for the residents. For example, for work costing €4,500 giving monthly energy savings of €40, the operator would be paid €30 per month to cover the cost of the work, with the remaining €10 going to the people occupying the dwelling. The contract between the operator and the occupants could be established over 15 years, so that the operator would be paid a total €5,400 in the end. Unlike third-party financing, the debt would be borne entirely by the operator, who would receive payment for the energy bill from the dwelling's occupants (tenants or owners). The latter would also benefit from a share of the savings on their energy bill. As in the case for district heating companies[16], the contract would be linked to the dwelling and passed on to the new occupant in the event of sale or a change of tenant.

However, as recent experience with third-party financing companies shows, there is a risk that the operator's remuneration may turn out to be lower than expected. Beyond the risk of non-payment, the savings on the energy bill may be overestimated or the renovation costs underestimated by the operator. These risks are currently poorly covered by the market. A public guarantee mechanism[17] would therefore be set up to insure operators in the event that the work undertaken proves unprofitable ex post: 50% of the value of each claim would be covered up to a limit of an absolute amount per operator defined *ex-ante*[18]. Thus, taking the previous example, if the energy savings were to amount to an average €32 per month, instead of the €40 initially forecast, the difference with the expected profitability over 15 years would amount to €1,440, half of which could be covered by the public guarantee if the operation became unprofitable as a result[19]. If a particular operator failed to anticipate this too often, the public authorities could issue warnings before withdrawing the public guarantee for future operations from this operator. The public authority would automatically receive all the profitability plans drawn up prior to the renovation work and all the ex-post data, to quickly identify any too frequent errors made by operators concerning savings on energy bills and the cost of retrofit operations. The energy performance contracts signed with household occupants would include the possibility of charging the effects of an increase in consumption to them[20] in order to maintain an incentive to limit their consumption. This would first reduce their share of the energy savings, then increase the energy bill in due proportion, correcting for any increase in consumption resulting from a change in the composition of the household (see Box 2).

As the prime contractor for the energy renovation of the building, the operator will call on a network of tradespeople and SMEs, providing them with training if necessary and ensuring quality control. The local authorities could select an operator-manager to work within a given area (a district, a town or rural area) and create a "concerted renovation zone" to pool energy renovation projects for buildings that lie close to one another. This could help increase confidence in the selected operator among the residents concerned and make owners more aware of the opportunity to renovate their homes, without any upfront payment or debt on their part.

Case studies for illustration

To illustrate the value of such a scheme in the current energy retrofit market, several cases can be analysed[21]. For each operation, the number of years required to pay back the retrofit work is calculated by including a rate of return for the operator (see table on next page). The calculation is

15. The ECD is not currently made public. Until a decision is made to share them with operators, they will be able to rely on their own expertise and existing technologies. A reform of the ECD is planned to make it more reliable.
16. See Ademe (2019), *Les réseaux de chaleur et de froid, état des lieux de la filière*.
17. This is a role that the Energy Renovation Guarantee Fund (ERGF) announced by the government could take over.
18. The 50% threshold is retained in order to be consistent with the rules that allow the European Investment Bank, the European Investment Fund and the Caisse des Dépôts to take over part of the public guarantee. The rest of the public guarantee could be taken over by the Grand Investment Plan (GPI), for example by reallocating part of the loan envelope for energy savings in public buildings, which is largely underused.
19. Other mechanisms can be applied to maintain profitability: an extension of the duration of the contract between the operator and the household and a revision of the 75%-25% sharing to the benefit of the operator. The contract will provide for such modifying clauses depending on the factors that result in lower-than-expected profitability, such as a sharp drop in energy prices.
20. Following energy renovation work, the resident household might, for example, choose to increase its comfort temperature. The reduction in estimated ex-ante energy savings following such a change in behaviour corresponds to what is known as the rebound effect. Clauses including target temperatures in winter are included in the economic performance contracts that already exist for jointly owned properties and can be reviewed as part of the target adjustment clause. See, for example: Agence parisienne du climat (2019), *La garantie de résultat énergétique en copropriété*.
21. These typical cases are taken from figures produced by Ademe, and available on the Ministry of Ecological and Solidarity Transition website as well as from figures produced by the General Inspectorate of Finance in its report *Les certificats d'économie d'énergie : efficacité énergétique et analyse économique(2014)*. The figures, particularly those relating to energy prices, have been updated to reflect the situation that prevailed before the Covid-19 crisis. See the working paper.

Box 2 — Agreement on the sharing of savings and losses between the operator-manager and the household in the case of a homeowner household

In practice, the agreement would take into account average energy consumption prior to the energy retrofit work: expressed in kWh[22], this consumption would be calculated over the five years prior to the retrofit, or over a smaller number of years. Th is baseline consumption, noted here as Q_0, would be adjusted according to any change in the composition of the household (counted in consumption units) during the agreement period. In addition to Qt, the energy consumption in year t after the retrofit work, the contract would only take into account the price – Pt – in year t of the energy used after the retrofit. Thus, the energy savings would simply be the difference D = ($PtQt - PtQ_0$) where PtQt is the amount of the actual bill and PtQ_0 is the theoretical amount in year t had the retrofit not been carried out.

Generally speaking, the operator would be paid 75% of this saving (i.e. 0.75D), with the rest (i.e. 0.25D) benefiting the household. To anticipate a potential rebound effect, the contract would define a target comfort temperature (20 °C for example). If the household eventually chose to set a higher temperature[23], the corresponding increase in the bill would remain at the household's expense: as such, the household would remain free to choose whether to use the savings for better energy comfort or to reduce its bill.

The agreement and the public guarantees would end after a number of years, once the retrofit costs have been covered by the savings on the energy bill. In the event that a dwelling is sold to another private individual, the agreement with the operator would be automatically transferred to the new owner. Similarly, in the case of a new rental contract, the contract would be taken over by the new tenant. In the case of collective housing under private co-ownership, the agreement would have to be signed with the entire co-ownership since thermal retrofit operations must involve the entire building if they are to be effective[24]. If the owner of a dwelling decides to combine the energy-saving operation with other work (extension, embellishment, etc.), the cost of the latter would be their sole responsibility. In general, however, the owner would benefit from a reduction in the cost of these embellishments or comfort-improvement works, as doing this the work at the same time as energy retrofit works would help optimise certain savings.

done with and without public aid, here limited to 30% of the value of the work up to certain ceilings. Given that there are other forms of aid which can be cumulated, or which are higher for the lowest-income households, the simulations carried out could actually be even more favourable either by reducing the number of years needed to amortise the operation or by increasing profitability for the operator.

For each operation, we calculate the energy savings from the first year following the energy retrofit operation, along with the reduction of CO_2[25] emissions. We also estimate the tax revenue for the public authorities, net of any subsidies paid[26], considering that the building sector will be able to cope with the increased activity by hiring and training new employees. The annual return on the operator's locked-in funds is also estimated.

Limited and controlled risks

An insurance mechanism can be envisaged to cover cases of vacancy and unpaid bills, which would add around 2% to the cost of the operation if market prices for this type of service are used. This is an overestimate, given that many landlords are already covered by this type of insurance. In the case of higher-than-expected retrofit costs or lower-than-expected energy savings, the operator bears half the cost of the retrofit the other half being charged to the guarantee fund if profitability turns out to be negative. This type of risk can be easily monitored by the regulator because it can compare the various operators' expectations for each operation with the actual outcome very soon after the completion of works. If one operator makes more frequent errors than the others, they can quickly be called to order or even removed from the scheme. If there is a type of retrofit operation that too frequently leads to operator errors, then the regulator can help them to reconsider their expectations.

The typical cases shown in the table are based on the Commissariat General for Sustainable Development (CGDD) scenarios for energy price trends, but the Covid-19 crisis has illustrated the risks linked to the volatility of hydrocarbon prices. Maintaining the oil price at the current level

22. If the energy used is not electricity, it is converted into kWh according to an agreement drawn up in advance by the public authority.
23. A simple and inexpensive system of two indoor and outdoor temperature sensors can be set up. Other detection systems can also be considered, for example to detect when a window is opened too long while the heating or air conditioning is on. Smart meters can also be useful for checking energy consumption in relation to the outside temperature.
24. A co-ownership may decide by a simple majority to enter into such an agreement as long as no costs are borne by the co-owners.
25. We use the estimated CO_2 content (in g/kWh) for each energy source mobilised for residential heating in the report "*Réseaux de chaleur bois: domaine de pertinence*" (CGDD 2016): electricity (148 g/kWh), gas (201 g/kWh) and fuel oil (270 g/kWh). These estimates are based on the OMINEA report *Organisationetméthodes des inventairesnationaux des émissions atmosphériques en France* by CITEPA (2019).
26. The additional compulsory levies collected are equal to 40% social levies on labour costs, plus 20% VAT on the remaining labour costs which are paid in net wages and spent by the beneficiaries and 20% corporate tax on the operator's margin. Labour costs are estimated on average at half the cost of the operation, which is a minor.

Table 1 – Typical cases illustrating the benefits of the scheme

STANDARD OPERATIONS AT LIMITED COST

1. Replacement of an oil-fired boiler to a gas condensing boiler for a 100m² house	• 25% energy savings • Repayment of the work in 21 years for an annual profitability of 3% • Aid of 30% of the cost of the work	• 2.2 tonnes of CO_2 saved each year • Cost of the operation net of public aid: €4,900
2. Insulation of the attic of a 100 m² gas-heated house	• 30% savings on the bill • Reimbursement of the work in 22 years for an annual profitability of 3% • Aid of 30% of the cost of the work	• 2.2 tonnes of CO_2 saved each year • Cost of the operation net of public aid: €5,300
3. Exterior insulation of the walls of a of 100 m² villa heated by gas	• 50% savings on the bill • Repayment of the work in 12 years for an annual profitability of 3% • Aid of 30% of the cost of the work	• 2.5 tonnes of CO_2 saved each year • Cost of the operation net of public aid: €6,400

PACKAGES OF HIGHER-COST ENERGY RENOVATION WORK

4. Complete renovation of a 104m² detached house built in 1981 on Îlle-et-Villaine and heated with electricity	• 75% savings on the bill • Repayment of the work in 17 years for an annual profitability of 3% • Aid of 15% of the amount	• 5.8 tonnes of CO_2 saved each year • Cost of the operation net of public aid: €22,300
5. Overall renovation of a 16th century 110 m² house located in the heart of a village in Vaucluse and heated by a wall-mounted gas boiler of about twenty years old	• 35% savings on the bill • Repayment of the work in 24 years for an annual profitability of 2% • Aid of 15% of the cost of the work	• 3.1 tonnes of CO_2 saved each year • Cost of the operation net of public aid: €12,900
6. Overall renovation of a 136 m² house in Jura built in 1955, extended in 1980 and heated with fuel oil	• 35% savings on the bill • Reimbursement of the work in 22 years for an annual profitability of 3% • Aid of 18% of the cost of the work	• 6.6 tonnes of CO_2 saved each year • Cost of the operation net of public aid: €33,400
7. 10-storey building built - in 1960 in an urban area in Haute Vienne	• 52% savings on the bill • Repayment of the work in 30 years for an annual profitability of 3%. • Aid of 14% of the cost of the work	• 2 tonnes of CO_2 saved each year for each of the 83 flats • Cost of the operation net of public aid: €11,700 per flat

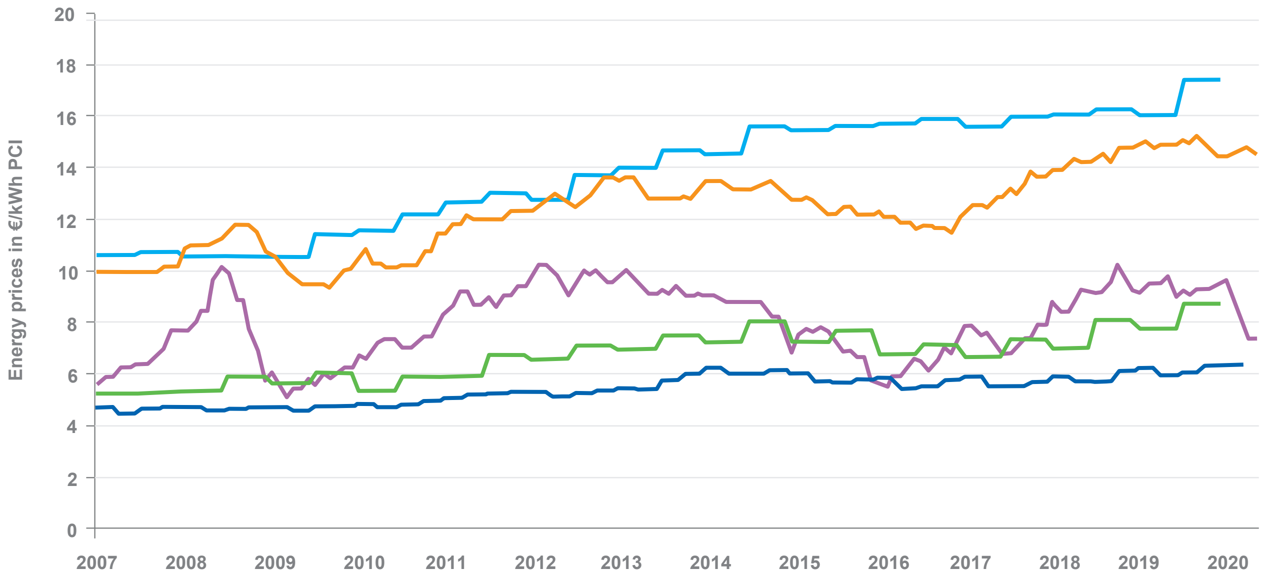
Source: France Stratégie

would make any ambition for the country's energy transition null and void. That is without accounting for a carbon tax increase – which is not on the table for the moment – meaning that carbon neutrality could not be achieved unless the public authorities ensure a bottom price for fuel oil and other carbon-based energies. In terms of consumer prices, the electricity price varies little in the short term but rose by a total 60% between January 2007 and June 2020 (Graph 3). Meanwhile, fuel oil and gas have fluctuated significantly, with an average increase over the period of 26% for domestic fuel oil and 13% for natural gas, despite the recent collapse in prices linked to the Covid crisis19. It should be noted that the prices presented here take into account the regulated tariffs for gas and that certain jointly owned properties and social landlords have negotiated supply contracts at lower prices. The operator-manager will also be able to negotiate lower prices (see below).

Would a significant drop in the price of these two carbon-based energies fundamentally call into question the operators' business model and the profitability of their operations? All operations based on the use of electricity as the post-retrofit energy source would barely be subject to this risk because the consumer price of electricity rarely falls and always in very limited proportions (between 2007 and 2020, the price fell 6 times for a maximum drop of 2%, with a catch-up effect shortly afterwards). This is not the case for natural gas and even less so for fuel oil, where the range of variations is greater. A first response is that fuel oil cannot be a sustainable energy solution for housing if France wishes to achieve carbon neutrality. If this solution is banned for energy retrofits under the proposed scheme, then a fall in fuel oil prices would not affect the *ex post* profitability of the retrofits, but it could dissuade individuals from committing to such an operation ex ante. As regards natural gas, which emits less CO_2, there is no reason to ban it in the medium term even if it could be partially replaced by green gas. Between 2013 and mid-2018, gas prices were 10% lower on average than in 2013. In the case of a fall in the gas price of this order of magnitude for households and over a similar period, the profitability of a gas-based retrofit operation would fall by the same proportion over this period.

In cases like this, several safeguards can be used before needing to call on the public guarantee. Firstly, the amortisation period can be automatically extended when the return on investment for the operator is lower than expected. For an expected duration of twenty years, this would

Graph 3 – Monthly energy price trends since 2007



Electricity: full price (subscription including 12 kWA double rate power) of 100 kWh at the regulated rate. Annual consumption 13 MWh, including 5 MWh in off-peak hours.

Propane: average price of 100 kWh ICP of propane in tank. Excluding provision and maintenance of tank and meter.

Domestic fuel oil: average price of 100 kWh ICP of FOO at the C1 rate (delivery of 2,000 to 5,000 litres). ICPI, 9.91 kWh/litre.

Natural gas: full price (subscription included) of 100 KWh at regulated tariff B1.3 uses. Annual consumption of 21.26 MWh HCV

Wood pellets in bulk: average price of 100 kWh PCI (bulk delivery of 5 tonnes at 50 kmJ). According to CEEB/Propellet France.

Source: France Stratégie

mean adding an additional two to three years to the agreement between the operator and the occupant household[27]. Secondly, it may be agreed to revise the share of the savings made (75% for the operator, 25% for the household), with an 85%-15% distribution during the low-price period so that the operator's return on investment remains constant despite the 10% lower gas price[28]. This type of clause can be included in the agreement and would be almost painless for the household as its bill would remain 7% lower than before the retrofit[29]. A third safeguard would be enabling the operators to act as energy service providers to the household, allowing them to secure the energy price through medium or long-term contracts, while promoting positive energy housing.

An overall positive economic equation

To give a few macroeconomic orders of magnitude, the system could permit an additional 250,000 thermal retrofit operations per year, on average, over twenty years, i.e. a total 5 million. Based on the case studies set out in detail in the working document, an average retrofit cost of 30,000 euros is taken into account, for an average energy saving of 50%. This therefore represents an additional annual investment of €7.5 billion, i.e. around 0.3 points of GDP for approximately 100,000 jobs created[30].

Broadly speaking, public finances would be impacted in three ways:

- These investments are partly financed by various public subsidies, estimated at a quarter of the total cost, meaning a cost for public finances of €1.9 billion per year (an average €7,500 per dwelling).

- This is a low estimation, as it does not take into account mobilisation of the public guarantee by operators if the profitability of an operation is miscalculated. It is difficult to estimate an order of magnitude, but as an illustration, we can assume a 20% loss rate, on a loss representing 20% of the total amount of investment, this would make an annual cost of €0.2 billion euros. As mentioned above, these risks could be controlled by the regulator.

- Conversely, this additional investment will create business and jobs in the construction industry, generating additional public revenues if the country is able to attract and train enough people for this sector to occupy the increased number of jobs: this is an important and difficult condition to meet. It would create additional social rights, which are not taken into account here. Assuming that there is no evasion effect on other sectors, and using the economy's compulsory contribution rate (44%), we achieve additional revenue of around €3.3 billion.

All in all, the positive impact on public finances could reach €1.2 billion per year. This figure is provided for illustrative purposes[31] and there are significant uncertainties, but it aims to show that the operation could be balanced.

Assuming an average reduction in carbon emissions of two metric tonnes per year per renovated dwelling, a cumulative total of 95 million tonnes of carbon could be avoided over the twenty-year period. This corresponds to an average annual saving of 1.1% of the country's emissions and 2.4% in a full year after 20 years compared to 2016 emissions, once the 5 million dwellings have been renovated. This potential reduction of approximately 10 million tonnes of carbon per year is greater than the sum of emissions from domestic air, sea, inland waterway, rail and other types of transport, excluding road transport.

How is it profitable for the operator?

Analyses of operation profitability must take into account the return on capital invested by the operator to finance the operation. As shown in the cases studies presented above[32], taking into account

an additional average margin of 20% for the tradespeople who carry out the work, or for the operator themselves, in case studies 1 (individual condensing boiler), 2 (attic and roof insulation), 3 (wall insulation), 4 (1981 detached house heated electrically), 5 (16th century detached house, heated by gas), and 6 (1955 detached house heated by oil) offer an annual return for the operator of 3% of the locked-in funds for variable repayment periods, which can be up to 36 years in the case of the 16th century house in Vaucluse. In the case of the 1960 gas-heated apartment building, for a subsidy of 13%, a 3% per annum return on the funds invested cannot be achieved in less than 40 years. With a 2% return on investment, however, the building will be amortised over 30 years, for a subsidy of 13% of the cost of the work.

27. Alternatively, the hypothesis of a 10% drop in energy prices the year following the renovation with no catch-up effect over the entire period would lead to a delay of between two and four years in reaching the profitability levels calculated for each of the typical cases, regardless of the energy source.
28. Even for a gas price 20% lower for a few years, a 95% share of the gains on the bill for the operator would make it possible to maintain the return on investment, while the household would continue to benefit from a reduction in its bill.
29. The household would nonetheless incur an opportunity cost corresponding to a 4% higher bill than if it had not carried out the renovation. However, this is a moderate cost for increased housing comfort and a mechanism that would reduce the increase in the bill in the event of an increase in energy prices.
30. France Stratégie figures based on the Nemesis model.
31. For example, if we assume a subsidy rate of one third, not one quarter, and a foreclosure rate of one quarter (not zero), then the balance sheet for public finances would be slightly negative (-0.2 billion euro).
32. See also the appendix in the working document.

Rates of return of 2% and 3% are not sufficient for private companies but could be adequate for semi-public companies and social economy companies. Several parameters would improve the profitability of operations for private companies. On the one hand, the case studies considered are average cases behind which there is wide disparity, in particular retrofit operations that are more favourable in terms of financial profitability, and which private operators could target first. On the other hand, the cost of renovation techniques is steadily decreasing. This is particularly true for the price of heat pumps and other equipment. The cost of carrying out the work may also fall with a higher volume of operations, an increase in the skills of companies and tradespeople and the optimisation of operations: an Ademe study shows that with work to optimise retrofit costs on real-life cases, the total cost falls by an average of 18.6%, with a record of 49.5%[33].

In addition, the operator could become an energy service provider to the contracting household. As such, it will be able to buy the energy needed for the households wholesale, with contracts at cheaper and more stable prices. The difference with the market price could be as much as 2 percentage points per annum, which in some cases would be above the break-even point required by a private company on its fixed assets. To improve profitability for a private operator, it could also be possible to assign it the full amount of energy savings, instead of the 75% suggested in this note. Irrespective of the other measures envisaged above, full allocation of the savings would push several of the case studies towards annual profitability of 5%.

Public subsidies would also be increased, especially for the lowest income households, or converted into an advance, repayable under a "return to better fortune" clause. The aid would be paid as soon as the retrofit operation is launched. In addition, the public authorities could provide loans at very low interest rates as well as equity contributions to private energy refrofit companies to increase operation profitability. This equity would not require financing by the operator. They would be repaid at their initial value, and would make it possible for the public authorities to earn a return on the capital invested in the event that French debt rates remain permanently negative. Furthermore, the public authorities' acquisition of a stake in these operator-managers, for example as part of the Investments for the Future Programme, would not have any impact on French public debt in Maastricht terms.

From a regulatory point of view, the adoption in law or in a European directive[34] of a carbon neutrality requirement for housing in 2050, and the introduction of intermediate steps such as a requirement for comprehensive energy retrofits by 2040, as recommended by the Citizen's Assembly on Climate, would constitute powerful incentives for property owners to take advantage of the measures available to support and finance the thermal retrofit of their homes, without this weighing heavily on their finances.

A virtuous mechanism

By combining different instruments, such as certification, support for individuals, third-party financing and a guarantee mechanism, this kind of scheme could respond jointly to the main obstacles to energy retrofit. First of all, the operators selected by the call for tenders would not only benefit from the public guarantee but also from a de facto "trust mark" and the visibility required to bring about the energy transition for its millions of potential beneficiaries. Since they would commit their brand image to each operation, these operators would continually need to ensure a high degree of quality and efficiency, which would boost their brand image among private individuals, investors and public authorities. With the quality guarantee provided by public authority regulation, households would no longer be held back by the fear of handling their relationship with renovation companies poorly.

The household credit constraint would also be circumvented since households would no longer have to bear the cost of the operation. On the contrary, they would see immediate benefits on their energy bill or on the value of their property. Such a system would also make it possible to align the interests of tenants and landlords and to overcome the financial constraints of co-owners, which are often an obstacle to energy retrofit operations. As they proceed with the energy retrofit work, operators will benefit from accumulated expertise, economies of scale, and research into new, more efficient methods and technologies. In addition, as they accumulate numerous long-term energy demands, they may be able to negotiate contracts with energy producers and secure supply at attractive prices, thereby improving the profitability of operations[35].

The rebound effect would be kept under control by a simple system of sensors and because the occupant households would have a financial interest in capping their consumption.

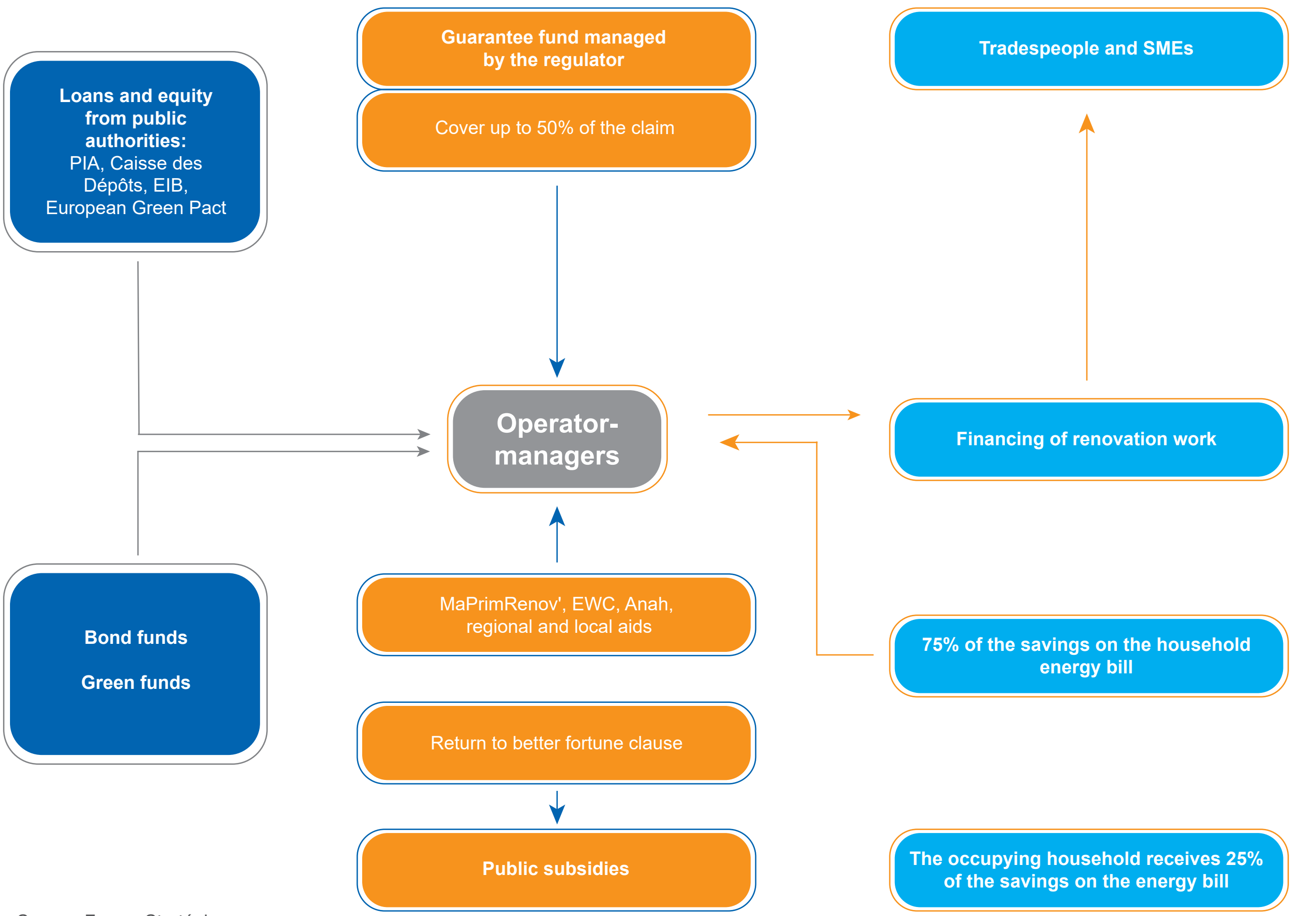
33. Ademe, Enertech (2016), *Analyse des coûts de la rénovation énergétique des logements en France*, July.
34. A national law offers few guarantees of credibility in the long term, as the experience of the HGV eco-tax illustrates. A European regulation is more credible from this point of view because it requires a qualified majority among the 27 Member States to be invalidated or changed.
35. Contracts of this type are being developed at very low rates, offered by some green electricity producers, particularly with large companies that use electricity heavily. It will be in the interest of the engineering contractors to make use of this possibility as it limits the price risk. By becoming a "price maker", the operator-manager allows households under contract with them to benefit from part of their market power vis-à-vis electricity producers.

They would also benefit from support from the operator and be able to rely on more efficient equipment, smart meters and the encouragement of energy-saving habits.

Since it would automatically receive the energy retrofit plans (cost and savings estimates) from the operators, the public guarantee fund would be able to continuously adjust its regulatory measures. In particular, it would be able to adapt the level and targeting of public aid so as to give the green light to operations that it deems appropriate and which would not otherwise be profitable (or not sufficiently). In addition, by collecting data on the real costs of renovation and energy expenditure, the fund will quickly be able to identify the too frequent overestimation of retrofit costs or energy savings for a certain operation or by a particular operator. It may thus decide to make certain operations ineligible, issue warnings to certain operators, or even withdraw[36] the public guarantee if they do not quickly correct their assessment errors or the quality of their work.

In particular, in the contracts between the public authority, the operator and the household, a return to better fortune clause could be envisaged: once the operation has been carried out, and if it proves to be profitable independently of public aid, the public authority would benefit from a share in the energy savings to reimburse all or part of the aid granted[37]. In this way, the system would optimise the public subsidy: it would only be mobilised when necessary to make operations profitable and would thus enable more operations; it would be reimbursed if the operation proves profitable, which does away the risk of operators behaving strategically in the search for subsidies.

Diagram 2 – Financing mechanism for the proposed scheme



Source: France Stratégie

36. Only on future operations, i.e. in a non-retrospective way, so as not to bring insecurity to the system.
37. Public aid would thus take the form of repayable advances.

CONCLUSION

The scheme proposed here makes it possible to align the interests of operators with those of the public authorities and households. In fact, the profitability of the operations, the savings made on the energy bill and the decrease in energy consumption would be mutually beneficial. Thanks to the competitive bidding of operators and the automated monitoring of retrofit plans, the public guarantee would provide security for investments, while only being used when necessary. The scheme would also improve the efficiency of existing public support by seeking out the most profitable operations and including "return to better fortune" clauses if necessary. Above all, households would no longer face obstacles to financing as they would have no direct costs to bear, and would no longer fear a lack of control over their relations with companies. They would also be able to rely on the quality control of the selected operators provided by the public authorities.

By structuring the energy renovation market in this way, the emergence of more efficient technologies would be encouraged and the expertise of the entire network of tradespeople and SMEs would be strengthened. Operators would provide real support to minimise the energy consumption of private households once the retrofit work has been completed, which is crucial in achieving carbon neutrality. The public authorities could choose to limit the operations eligible for the scheme to comprehensive renovation operations only[38]. Operators would also be encouraged to develop positive-energy housing. As the scheme gains momentum, the rate of coverage ensured by the proposed new guarantee fund could be gradually reduced, or even totally done away with in the long term, once the energy-efficient retrofit market achieves maturity.

Key words: energy retrofit, housing, private housing stock, guarantee fund, energy bill, operator-manager

38. The Citizens' Assembly on Climate defines a comprehensive renovation operation as the combination of works on all or part of an existing building other than an extension covering at least the following categories of works: insulation of walls, lower floors and roof, replacement of glazed surfaces, relocation of heating and ventilation equipment; and making it possible to achieve an energy consumption level determined using the energy performance diagnosis method, not exceeding the threshold of 90 kWh of primary energy per square metre per year.

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