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PARLIAMENTARY OFFICE FOR SCIENTIFIC AND TECHNOLOGICAL ASSESSMENT

Briefing 6

The Energy Efficient Renovation of Buildings

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Thermic image of a building which has only partly been insulated
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Summary

- *In order to reach the objectives in the fields of the reduction of greenhouse gases and of energy consumption, a huge break will be required in the area of the energy efficient renovation of buildings.*
- *Launching a momentum for energy efficient renovation implies being in a position to measure the unit results obtained, to follow the overall development of the sector, to concentrate efforts in spheres where energy efficiency has been proven, as well as to identify the various types of obstacles and to overcome them.*
- *In order to come up with new, adapted solutions, scientific research must be developed and strengthened along multiple lines: numerical, material, social scientific lines etc.*

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The Context of this "Briefing"

In France, the building sector produces around 25% of greenhouse gas emissions (36% being the average in the EU) and uses around 45% of the final energy consumption (40% in the EU).

Consequently, **our ability to reach the national objectives in the fields of the reduction of greenhouse gases (a decrease of 40% by 2030 and of 75% by 2050, in comparison with 1990) and of final energy consumption (decrease of 50% by 2050, by comparison with 2012) is strongly dependent upon the achievement of the objectives set down for the building sector**[(1)]:

- The reduction of greenhouse gases by 54% by 2028, and by, at least, 87% by 2050, in comparison with 2013;
- The reduction of energy consumption by 15% by 2023 and by 28% by 2030, in comparison with 2010.

Given that the pace of renewal in the building sector has been around 1% per annum for the last 30 years, the considerable progress implemented on the performance of new buildings will only have, even in the time frame of a decade, a limited effect on the overall emission characteristics and on the consumption of buildings.

European directives concerning the energy performance of buildings

Dating from May 30, 2018 (with transposition due in 20 months), directive 2018/844/EU which updates directives 2010/31/EU and 2012/27/EU, provides for, in order to reach the European objectives for the reduction of greenhouse gases, the setting-down, in each member state, of a long-term renewal strategy whose objective would be to provide, by 2050, a highly energy efficient and carbon-free building sector, especially through measures seeking to encourage major renovations, to target "sieve-like" buildings, to use digital technologies, to mobilize and to optimize investments in renovation, for example, through the bringing together of projects by means of platforms or consortiums of small and medium sized businesses.

Thus, **success in reaching the objectives set down for the sector will mostly depend on the possibilities of improvement of performance in the existing housing stock.** This is the objective of energy efficient renovation which covers all works aimed at reducing the consumption of energy and of greenhouse gases in buildings and that of their inhabitants or of their users in the case of the tertiary sector.

In terms of actions to be implemented, priority must be given to measures which encourage energy efficient renovation concerning the improvement in the performances of new buildings, which have, in addition, the drawback of using more raw materials and, in many cases, quality neighboring agricultural land.

Since the appearance, in the 1970s, of concerns regarding energy performance in buildings, the stakeholders (political authorities, administrations, bodies, associations, etc.) have given priority to the improvements of the regulations, to the methods and to the technologies designed for new buildings. However, **the approach to be taken in the construction of new buildings is not entirely transposable to the field of renovation,** especially when the stated objective is one of massification. In addition, the unit gains being aimed for, around several tens of kWh/m^2/year in new construction, are much less than those in the renovation of the least well insulated buildings which are around several hundred kWh/m^2/year.

The example of Germany

In Germany, three measurements encourage the renovations which are put forward and financed by the program for "renovation with high energy efficiency" of the Public Development Bank KfW (*Kreditanstalt für Wiederaufbau*) : **the first concerns the overall performance after renovation, the second deals with the progressivity of funding according to the energy performance which has been reached, and the third looks at the advice of a heating engineer** on the works to be carried out**.** He/she is actually on the site and certifies the results obtained. This approach led, between 2008-2015, to a 11.1% decrease in the final energy consumption of housing. This positive result is however to be seen in the perspective of the objectives set down concerning the annual rates of renovation (1% for individual houses and 1.3% for collective housing compared with an objective of 2%) or with the fall in final energy consumption (objective of 20% by 2020).

The German approach, which is aimed at obtaining measurable results, along with the fact that their sector is better structured and trained, has meant that they reached better results than those obtained in France, but which are still insufficient on account of **a disenchantment of households for overall renovations which are considered too heavy and too costly**.

■ Clearly insufficient national results, despite substantial investment

The French law referred to as "Grenelle I" dating from August 3, 2009 set down an objective for the reduction of energy consumption for buildings of 38% between 2009-2020. To reach this objective it provided for the implementation of financial incentives which aimed at carrying out, over the said period, 4 million major renovations of private residences and 9 million "intermediate" renovations, without putting forward an exact figure for the energy performance level that was to be reached.

These financial incentives were revised several times in order to increase their efficacity. In the year 2015 alone, their cumulative amount reached 3.8 billion Euros [(2)].

Although the results obtained as regards the number of private homes renovated came close to the objectives for certain years [(3)], this is, however, not the case concerning the objective for the decrease in consumption: between 2009-2016 it thus only decreased by 1% (from 498 TWh to 493 TWh) [(4)].

Reaching national and sectorial objectives thus implies a true break with our former approach towards energy efficient renovation.

Towards a more rigorous approach to the energy efficient renovation of buildings

Launching a momentum for controlled energy efficient renovation which would allow us to reach the climate and energy objectives set down, implies being in a position to measure the unit results obtained, to follow the overall development of the sector, to concentrate efforts in spheres where energy efficiency has been proven, as well as to identify the various types of obstacles and to overcome them.

▪ **The measurement of the performances of this package and of the real consumption of the buildings constitutes an essential prerequisite for the piloting of energy efficient renovation.**

Research carried out both in France and abroad over the last few years has led to the overcoming of obstacles and to adopting several measurement techniques which allow us to reach, for different types of building, a sufficient level of precision. These are today available [(5)]. Thus, it is becoming possible to assess them with an eye towards implementing them on a large scale[(6)]. This constitutes an essential condition for the setting-up of an enforceable energy performance assessment, envisaged for 2020, for the introduction of an guarantee for energy efficient performance which would return confidence to the decision-makers, for the generalization of the correlation between the valuation of property and its energy performance, as well as for the simplification and the comprehensibility of funding for renovation, by replacing targeted funding which depended upon the characteristics of the products, by funding based on the overall performance of a renovation operation.

▪ **The setting-up of a real observatory for the building trade** would lead to a permanent monitoring of the actual situation in the sector, on both national and local levels, as well as, of its development and would mean the priority targeting of buildings to be renovated in order to create grouped projects and to assess the appropriateness of the actions taken. This approach has already been initiated, with the proposal for the centralization of building surveys in an observatory managed by the *Centre scientifique et technique du bâtiment (CSTB)* (Scientific and Technical Center for Building)[(7)].

This approach must be extended and accelerated in order to set up a data repository which can be used by decision-makers and researchers alike.

▪ For reasons of efficacity, **a real priority must be given to "sieve-like" buildings in the energy efficiency and greenhouse effect fields.**

The quickest gains could, in fact, be made on the 7.4 million homes which consume more than 330 kWh/m^2/year. For example, the advantage resulting from the insulation of a wall is directly proportional to the initial energy loss even more than to the characteristics of the insulation material used. **As regards climate issues but also health questions** (studies carried out by the WHO have shown that 1€ invested in energy efficient renovation works leads to 0.42€ of savings in public health expenditure) [(8)]**, it is necessary to specifically deal with the 2.6 million "sieve-like" buildings (representing 35% of the total) occupied by low-income households.**

Key figures concerning fuel poverty

According to the last study of the *Observatoire national de la précarité énergétique* (ONPE) (the National Observatory on Fuel Poverty), in 2013, **5.6 million households, i.e. 8.8% of the population,** were affected by fuel poverty.

The initiative called "Rénovons" or "We Should Renovate" **assesses the number of "sieve -like" dwellings** (those consuming more than 330 kWh/m^2/year in primary energy) **at 7.4 million** in the private residential housing stock in France**, of which 2.6 million are occupied by low-income households.**

▪ It is essential to **invert the growing disenchantment of households, which has been noticed in France and abroad, concerning energy renovation.** This implies better identifying the conditions which lead to a decision to renovate, either in an individual dwelling or in a collective building and thus to make such a decision more appealing by associating it with the improvement of the quality of life in the building and by developing new product offers, adapted to diverse situations, "taking on-board" several features, and all this at an attractive price. Reestablishing confidence also implies ending the huge dispersion of advisory services to private individuals, by setting-up a national piloting scheme, more structured than the energy efficient renovation platforms, which could become a compulsory step in obtaining funding for renovation.

▪ **Certain regulatory obstacles to innovation in energy efficient renovation must be addressed**.

Thus, the implementation of the measurement of the real performance of renovation operations would limit the prior certification of products purely to the criteria dealing with safety, which would lead to a shortening of the time periods and a decrease in the costs relevant to the placing on the market by innovative companies. It would also open up renovation to

alternatives approaches and protocols such as those coming from passive energy construction.

▪ **New financial engineering solutions must be found,** for example, by introducing reverse mortgage mechanisms based on life lease which would allow the repayment of principle at any moment of change of legal status concerning the renovated property [(9)].

Multiple avenues of research must be developed

Several avenues of research seem essential in order to overcome the obstacles to the energy efficient renovation of buildings in France, as in other countries which are more advanced in this field.

▪ **The development of digital technologies could open the way to a multitude of new applications,** most of which have yet to be imagined. Among many such ideas, we can mention the active management of energy in buildings through connected objects [(10)], which allows for the control, in real time, of the equipment according to the actual use of the premises as well of the consumption of the building [(11)], or even the massive analysis of the data[(12)], in order to target, in a housing stock, those whose renovation would require priority. Artificial intelligence techniques could facilitate the identification of the most relevant renovation works for a specific building[(13)]. By contrast, effective digital solutions for new constructions, such as BIM (*building information modeling*), are not necessarily transposable without substantial adaptation, to the field of renovation [(14)].

▪ As regards insulation, the characteristics of the materials developed for new constructions, often thick and restrictive in terms of installation, are not necessarily the best solutions for diversity when it comes to renovation.

New, more efficient, simpler or quicker to install materials are yet to be developed and industrialized, in order to bring solutions better adapted to the configuration and the type of each building. Thus research has led to the development of new, extremely efficient, thermal insulation materials: aerogels[(15)], for example, can easily be integrated when it comes to internal wall cladding or included in the renovation of a façade[(16)], as can thin insulating or even vacuum insulated materials. **Such research deals more and more with bio-sourced materials and this leads to the environmental impact of renovations.**

▪ **Research on air quality and internal comfort, as well as the respect of the existing buildings,** must also be followed up. So that renovation becomes attractive, it is indeed essential that it be seen, not only as a potential sources of prospective savings, but also as, in the future, a source **of real improvement, felt immediately, of the conditions of life in buildings, in public spaces and in companies**. Thus, in the tertiary sector, the improvement of productivity resulting from better working conditions could become one of the main arguments leading to a renovation operation[(17)].

▪ In the field of heat production, technological barriers are still to be overcome. In the case of gas-fired boilers which use an energy source which is easy to stock but is reliant on carbon, the reduction by 90% of greenhouse gases by 2050 imposes **an increase in the use of non-carbon-based sources**[(18)]. In the same way, it is also necessary **to improve**, during very cold periods, **the efficiency of aero-thermal heat pumps** which can reduce, by a factor of 3 to 5, on average, electric consumption[(19)]. In addition, the development of technologies leading to the recovery of the "waste heat" due to the fluids leaving a building, must also be examined in greater depth.

▪ **The contribution of an approach based on social sciences also appears to be essential,** especially in order to pinpoint the factors which lead to the decision to carry out the renovation of a dwelling, in order to better imagine the development of the behavior of the inhabitants of a building, especially so as to limit the boomerang effects of a renovation. This is also even important to identify the factors which lead a specialized builder to favor certain renovation solutions which could encourage the drive towards innovation[(20)].

The necessary strengthening of research

As regards the issues linked to the reaching of climate and energy objectives, **current public and private research does not appear to be at a level to respond to the scientific and technological challenges we face.** In the field of private research, the construction sector, which in France has an annual turnover of around 130 billion Euros, only allots about 0.1 % to 0.2 % of this amount to research, as opposed to 2% on average in other sectors. This situation is, partly, on account of the sector's structure, as it is mainly made up of very small companies and a limited number of large groups, which are, with some very few notable exceptions, not very mobilized on the issues of energy efficient renovation. In addition, medium-sized companies are almost inexistent in the sector. This is partly made up for by the contribution of research, especially on materials and the digital impact, carried out by companies outside of the sector; for example, silica - a product championed by the chemical industry which could lead to new insulating materials

This insufficient financing of private research coincides, paradoxically, with a growing lack of interest of the big public research and financing bodies in the field of the energy efficient performance of buildings, at a moment when such research is becoming crucial. **As regards the number of people involved, the research community in France has seen its numbers decline,** even though such numbers had been even further decreased than in European or in North American countries where there is a structured public research tradition in this sector. **French research budgets are going through the same decrease.** In particular the funding provided by the *Agence nationale de la recherche* (ANR) (French National Agency for Research) for projects concerning renovation is decreasing : in the last few years only one or two projects have been given to young researchers in the building field in the framework of the sixth challenge concerning urban systems (town-planning, buildings, mobility etc.).

It seems, more than ever, **desirable to place research on building at the heart of French policy** concerning energy efficiency, especially by inverting the trend towards the decrease in allotted funding.

As France no longer possesses a great research center in this field, even if there are very competent teams within the CSTB (The Scientific and Technical Building Center) , the CEA (Atomic Energy Commission) and certain other regional university centers, it would be necessary to continue efforts to bring these scientific groups together. **The setting-up, in time, of a dedicated research institute**, perhaps partially funded by the private sector, which would lead to the establishment of adapted infrastructures and to providing to these works the visibility necessary, at a national and an international level, to attract new talents, could represent a major step and contribution to this approach.

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Experts and scientists consulted

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Various units UMR - CNRS