Control of the Ep-Regulation in 3 French Regions: Approach and Preliminary Results on 29 Buildings

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ABSTRACT

This paper focuses on energy performance compliance checks to the French EP-regulation RT 2000 and the way they are performed in Rhône-Alpes, Burgundy, and Franche-Comté. It gives an overview of the approach developed and used which consists in collecting calculation details provided by consultants; visiting the construction site when the insulation is installed; and visiting the building at commissioning. The compliance to the EP-regulation is analyzed at each of those steps. The paper also discusses the preliminary results of assessment performed on 10 service sector buildings, 10 multi-family buildings, and 9 single-family houses. Globally, they show that although there may be significant discrepancies between stated and actual conventional energy performance, most buildings in this sample comply with the EP-regulation after the first visit.

KEYWORDS

Energy performance regulation, performance check, residential buildings, service sector buildings

INTRODUCTION

Regulatory compliance checks on buildings have been initiated in France in the early 70s. These inspections are meant to urge contractors and project owners to build according to the rules set by the building code. They are also meant for the ministry for housing to monitor the application of the regulations.

Today, the compliance checks performed by the CETE network (Technical Studies Centers of the Ministry for Equipment) cover 8 fields: fire safety, balustrades, acoustics, automatic garage doors, stretcher transport, accessibility, energy performance, and ventilation. The controls are ordered by the state as a judiciary police mission on samples taken from the ORTEC (Observatoire de la Réglementation Technique) database managed by CSTB. The CETE network implements the inspections; by law, they can be performed on site within 2 years after the building is declared finished by the owner.

This paper focuses on EP-regulation checks and the way they are initiated in Rhône-Alpes, Burgundy, and Franche-Comté. The results obtained on a sample of 29 buildings are analyzed. The analyses do not address the summer comfort issue.

BACKGROUND

The French regulation on energy performance is based on the order dated 29/11/2000. To comply with this regulation, 3 major requirements must be fulfilled:

1. The conventional energy consumption (C in kWh primary energy) of a building must be smaller than that of a reference building ($C \leq Cref$). The reference building is the geometrical twin of the project, but each component (ex. window U-value) is assigned a reference value. The relative energy performance (EP) is defined as 100 * (1 – C/Cref) in %.
2. Minimum requirements must be met. These include performance requirements (ex. U-values) or requirements on means (ex. lighting control in commercial buildings);
3. The conventional indoor temperature in summer has to be lower than that of the reference building for non air-conditioned buildings.

Generally, calculations are performed with approved softwares based on a public domain engine (THC motor) to make sure that these requirements are met. Standardized input files can be generated so that thermal simulations may be performed using THC motor alone, without commercial software. Note that the project owner must be able to prove that the building complies with the regulation; therefore, he must be able to justify all input values to the software.

INSPECTION METHODS

The EP regulation inspection method is divided into 5 major steps: preparation; analysis of building specifications; field work; reporting; follow up. To avoid lengthy comprehensive controls that would imply redoing the building energy study, the underlying philosophy of the method is to identify potential weaknesses and to target control efforts on these.

1. Preparation. This step consists in contacting the project owner and gathering all information relevant for the control. This includes building specifications of course (U-values, thermal bridges, drawings, etc.) but also the planning as well as the standardized input files to the EP software used.
2. Building specification analysis. The inspectors follow a procedure that allows them to check the consistency of geometrical inputs. This starts simply with checking that the floor areas, cold wall areas, and volumes are consistent between the project and reference files. Minimum requirements are checked. Besides, sensitivity analyses are performed to identify the surface areas to which the energy performance is most sensitive and comprehensive checks may be performed depending on the weight of input parameters (surface areas or U-values) on the energy performance. Sensitivity analyses are also performed with the equipments. This allows the inspector to identify the parameters that have a significant share in the energy performance and to prioritize the field checks on these. Re-evaluation of the energy performance based on actual performances can be done on some parameters.
3. Field work. The field work is divided into two visits on site. A preliminary visit is performed when the insulation is installed. The inspectors check that the components put in place comply with the inputs of the EP study. This concerns

mostly envelope insulation, including thermal bridges. A second visit is performed when the building is finished. At this stage, all equipment is checked (name-plate performance) and measurements may be performed (e.g. ventilation airflow rates), but priority is given to sensitive equipments identified in the analyses of building specifications.

4. Reporting. Non-conformities are recorded in minutes that include legal facts as well as observations. A report describes the discrepancies found and how they were solved; in addition, it includes comments and recommendations mostly on aspects that are known to affect the energy performance although not unambiguously covered by regulation (e.g., poor installation of insulation). The inspectors also report non-conformities on standard forms for statistical processing. Although operational, this procedure is not quite mature yet.
5. Follow-up. When non-conformities are found, the report is sent to the owner. Also, state authorities forward the minutes to the attorney general. In parallel, an out-of-court procedure starts to remedy non-conformities. Note that the attorney general does not interfere with this procedure if it can be settled between the owner, the state authority, and the inspector.

INSPECTION TOOLS

While the inspectors rely on existing tools for other items controlled for steps 1, 4, and 5, a specific tool is being developed and tested for steps 2 and 3. The tool accompanies the inspector in a step-by-step procedure. It makes use of the THC motor input files to perform sensitivity analyses; to flag inconsistencies and suspicious inputs; to identify which parameters should be control in priority. The procedure is semi-automated: some inputs are needed especially for the envelope description; however, the sensitivity analyses are automatically generated with a macro. The results of the sensitivity analyses are presented in a graph that gives both the weight of the each project parameter on the energy performance (all other parameters being set to reference values) and the sensitivity to changes (Figure 1). Also, a consulting company has performed a synthesis of standard solutions based on a sample of 650 individual houses, 435 multi-family buildings, and 36 service sector buildings. This tool appears to be very useful to be able to judge in a quick-glance if the project is obviously non-compliant. It is also useful to more experienced inspectors to find out whether the solutions proposed are suspicious. Finally, the inspectors have pressure and airflow rate sensors to check that the airflows at the ATDs are not excessive. The use of IR thermography has been envisioned for raising awareness, but it appears to be difficult to make it useful in a regulatory control approach.

COMMUNICATION WITH OWNER AND ENERGY CONSULTANTS

The project owner is legally responsible for the application of the regulations. In fact, in France, the building permit is delivered considering the respect of town planning regulations alone. However, the owner commits himself to follow the building code when signing the building permit. Therefore, the inspector has to discuss primarily with the owner, who may refer to his energy consultants to answer specific questions. In turn, when first contact is established, the inspectors often communicate directly with the energy consultants. When discrepancies between building specifications and the actual construction are raised, it remains the responsibility of the owner to remedy the problems or justify that, with its actual characteristics, the building complies with regulation. It is also his responsibility to inform the inspector of the remedial actions envisioned and performed in view of a final check.

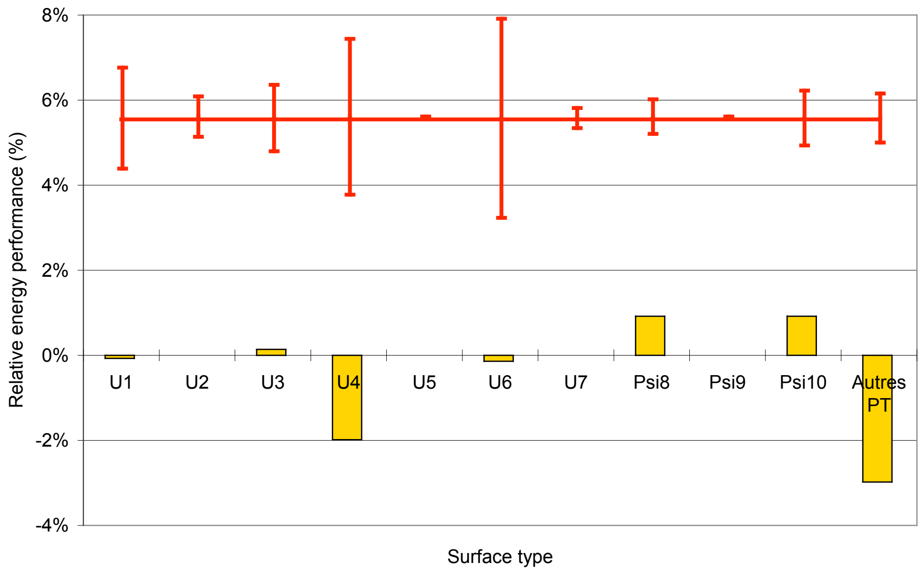

Figure 1: Example of sensitivity analyses of energy performance to envelope U-values and thermal bridges. Parameters Ui or Psi i represent area or linear losses defined in RT 2000. “Autres PT” represent thermal bridges other than those taken into account in Psi i.

PRELIMINARY RESULTS

At this stage, few buildings went through the whole inspection process. Therefore, the preliminary results presented here refer mostly to the quality of thermal studies and discrepancies noticed between stated and actual insulation characteristics. Concerning EP calculations, major non compliances concern violated minimum requirements, incorrect definition of thermal bridges, and underestimated cold surfaces. Inconsistencies are generally more frequent in service sector than in residential buildings. As shown in Figure 2, we found numerous discrepancies on all surfaces. Discrepancies consist in insulation thickness reduction (ex. punctually under windows, entirely because of a new design) or higher thermal conductivity (ex. efficient product changed to standard). Energy consultants often prescribe in their calculations that major thermal bridges be treated, as they tend to represent a significant share of thermal losses. Unfortunately treatments can rarely be checked on site because they are often inaccessible after installation. The insulation level is usually slightly higher than the reference: on a sample of 22 buildings in Rhône-Alpes, the median of the relative U-value (1 – U/Uref) for individual houses is 10.7%; 4.6% for multi-family buildings; 2.6% for service sector buildings. On the same sample, the relative energy performance is 11.2%, 8.3%, and 9.3%, respectively. This trend confirms that designers put more emphasis on energy efficient equipments such as high-efficiency boilers and fans, advanced regulation, or humidity-controlled ventilation systems than on the envelope.

Discrepancies in insulation characteristics rarely imply the non-compliance on conventional energy consumption, although the products installed may not even comply with minimum requirements. Our experience shows that the most sensitive discrepancies are those found on equipments during the 2^{nd} inspection. However, on seven residential buildings where the inspectors have asked the energy consultants to revise their studies to correct the discrepancies noted and unsolved, the results show that the constructions remain compliant with the changes (Figure 3). Note that energy consultants do not seem to update their calculations although some problems resulting from changes could more easily be solved if raised early. In few instances, some products had to be completely replaced for the building to comply with the EP regulation.

LESSONS LEARNED

The regulatory controls performed in Rhône-Alpes, Burgundy, and Franche-Comté have been initiated in 2004. The sample studied here, although limited, allows us to draw a number of lessons on the procedure, the methods used, the perception of the controls, and the compliance itself. Regarding the procedure, the major difficulty is that it is a long process: it requires selecting buildings before the beginning of construction, and ends after the building is finished. Also, progress should be made in the information delivered to the owner to clarify the framework, objectives, procedure and follow-up of the controls. Regarding the methods, the building specification analyses, although not exhaustive, allows the inspector to prioritize check points and to justify additional requests or remedial actions. The controls performed in this sample show that these analyses, coupled with site observations, raise a number of problems, namely erroneous information (ex. missing thermal bridges, no fan power or hot water losses) or discrepancies between stated and actual building characteristics (ex. changes in equipment characteristics, input errors of U-values). The visit on site is very interesting and informative, both for the inspector and the owner who can remedy possible problems more easily at this stage than when the building is finished. It is also a privileged time for the inspector to raise awareness near contractors. Overall, with the tools described in this paper and a careful planning, we estimate to 3 the number of person-days required to perform a control.

CONCLUSIONS AND FURTHER WORK

This paper gives optimistic perspectives for EP-regulation control provided that adequate methods and tools be developed and used. It also shows that our method, although not exhaustive, raises a number of problems in today's practice. One important aspect concerns the updating of the energy study, which is rarely performed although there may be significant changes between the design and the construction phases. This will change with the new regulation RT 2005 which requires that a synthesis of the energy study be done when the building is finished and be transmitted to the owner. This new version of the regulation should ease the control process given that a summary of the building characteristics will be available in a standardized XML file. Additional work is needed to address the summer comfort issue, also covered by the French EP-regulation.

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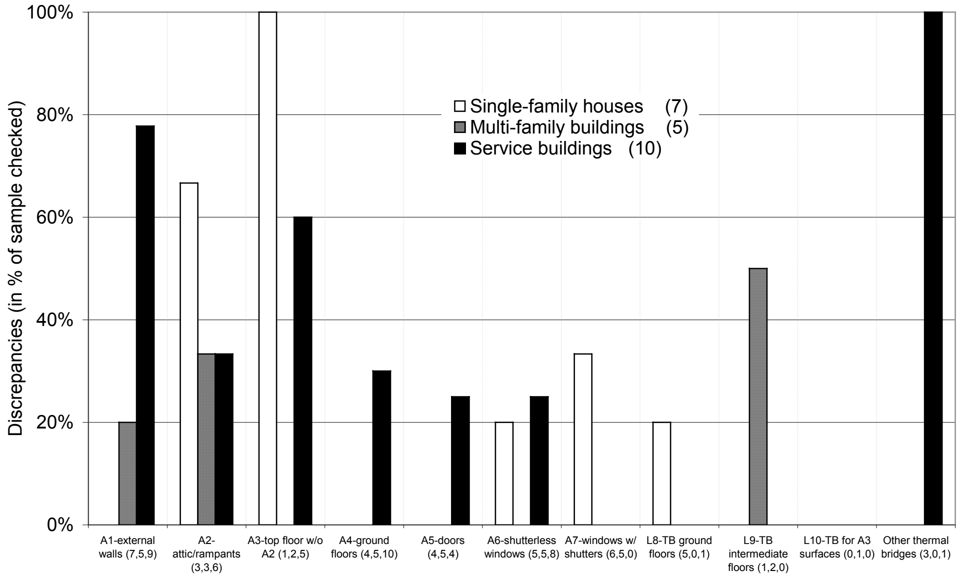

Figure 2: Occurrence of discrepancies between stated and actual characteristics on 22 buildings after first visit. Sample size checked in parenthesis.

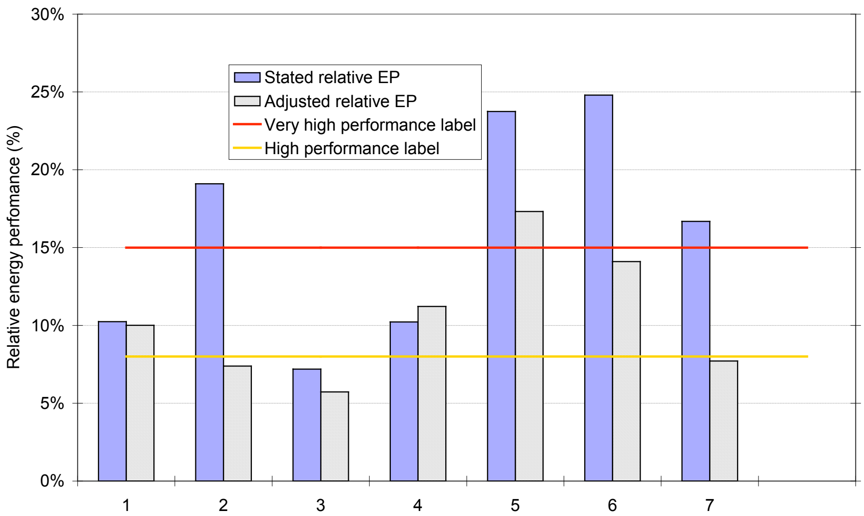

Figure 3: Stated and adjusted energy performance of 7 residential buildings in Burgundy and Franche-Comté (Fournier et al., 2006).