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Enforcing energy performance requirements in new and refurbished buildings

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1 Introduction

The energy performance requirements for new and renovated buildings are one of the key elements of the Energy Performance of Buildings Directive (EPBD). Article 4, 'Setting of minimum energy performance requirements', states that "*Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieve cost-optimal levels*". According to Articles 6 and 7, "*Member States shall take the necessary measures to ensure that new buildings and existing buildings that undergo a major renovation, meet the minimum energy performance requirements set in accordance with Article 4*". Member states will have to tighten the requirements in the coming years to reach Nearly Zero-Energy Buildings (NZEBs) by 2021.

Compliance checks of the energy performance requirements were already a reality in many Member States (MSs) before the introduction of the EPBD. The implementation of sanctions is now formally required by Article 27 of the EPBD 2010/31/EU. This article states that MSs shall lay down penalties applicable to infringements of the regulation. According to Article 28, MSs shall adopt and publish, by July 2012 at the latest, the laws, regulations and administrative provisions necessary to comply with Article 27. MSs should apply penalties to infringements of their regulation implementing the EPBD the latest by January 2013.

In its report 'Regulatory Enforcement and Inspections'[1], the OECD underlines that ensuring effective compliance with rules and regulations is an important factor in creating a well-functioning society and trust in government. If not properly enforced, regulations cannot effectively achieve the goals intended by the governments. Regulatory enforcement is therefore a major element in safeguarding health and safety, protecting the environment, securing stable state revenues and delivering other essential public policy objectives.

[1] OECD (2014), *Regulatory Enforcement and Inspections*, OECD Best Practice Principles for Regulatory Policy, OECD Publishing. http://dx.doi.org/10.1787/9789264208117-en

The delivery of regulatory outcomes is not based only on how regulations are designed. In the last decade, OECD countries have been investing time and resources in examining the need for regulation and assessing regulatory options. Most governments improved the design of regulations through regulatory impact analysis and stakeholder engagement mechanisms, and searched for opportunities to remove unnecessary burdens on the business community and on citizens. Regulatory enforcement has been overshadowed by these initiatives in most countries so far. Moreover, regulators in many countries are increasingly under pressure to do 'more with less'. While demands to better protect the environment and the health and safety of citizens have increased, the current economic crisis forces governments to reduce spending on public administration, including regulatory enforcement activities.

The major challenge for governments, according to the OECD, is to develop and apply enforcement strategies that deliver the best possible outcomes by achieving the highest possible levels of compliance, while keeping regulatory costs and administrative burdens as low as possible. A well-formulated enforcement strategy is one that provides correct incentives for regulated subjects, as well as appropriate guidelines for enforcement staff, and minimises both the monitoring effort and the costs for the regulated subjects and the public sector.

The position expressed in the OECD report is in line with the vision of the EPBD that a law that prescribes energy performance requirements is not sufficient to reach the goal of energy efficient buildings with a good indoor climate in the new building stock. Experience in recent years has shown that regulation without enforcement leads to lack of compliance, whereas the existence of penalties increases compliance with the regulations.

EU MSs are gaining more and more experience in this field. This paper gives an overview of the status and methods used by MSs to check compliance with energy performance requirements of new and refurbished buildings.

2 The compliance checking framework

MSs have different approaches to demonstrate compliance with energy performance requirements for new buildings and major renovations. Some MSs have a long history in compliance checking with energy performance regulations, while others recently adapted their regulations to implement penalties according to EPBD Article 27.

2.1 Legal framework

In general, two different approaches exist in the legal frameworks for energy performance requirements between MSs.

The first approach is a building regulation approach. In this case, all requirements for new and renovated buildings are part of one building regulation. This building regulation can contain requirements for different technical areas, e.g., fire safety, structural safety, acoustics, toxics, waste disposal, accessibility to the building, electrical safety, ventilation and energy performance. Building regulations in the UK, Ireland and The Netherlands, among others, are typical examples of this approach.

The second approach is a dedicated regulation for energy performance requirements and calculations. Germany, Belgium (Flemish Region), France, Portugal and many other countries adopt this approach.

This difference in approach can influence the framework for sanctions on infringements. If the energy performance regulation is but one part of a global building regulation, the sanctions are in most cases not specific for energy performance infringements, but the same for all types of infringements. If the energy performance regulation is a separate legislation, the control system and the sanctions can differ from those for other infringements related to new buildings.

Experience shows that it is often more compelling to enforce energy performance requirements if they are part of a global building regulation. As resources and budget for enforcement are limited, some MSs have to make a hard choice between different types of requirements to enforce.

2.2 Who is responsible for compliance

The owner of the building permit is in general the person responsible for compliance with energy performance requirements. However, some countries have special provisions to protect private builders and buyers of new buildings: the legislation appoints the developer and/or the professional advisors (designer, architect, energy expert) as (co)responsible for compliance of the building with energy performance requirements.

Some MSs protect private builders and buyers of new buildings by assigning the responsibility to comply with the requirements to the developer, the designer or the energy advisors, the professionals responsible for the building process.

2.3 Who reports on compliance

MSs use two means to report on compliance:

- The builder has to appoint a competent expert who makes the energy performance calculation. Depending on the MS, this expert has more or less responsibility.
- The designer/architect has to declare that the building complies with the requirements. Calculations can be done, but are not mandatory in every MS. It is obvious that a calculation is more accurate and trustworthy than a simple declaration.

2.4 Who checks the compliance

In most MSs, a national, federal or regional governmental organisation is responsible for checking the compliance of new buildings with the energy performance requirements (Figure 1). Communities and local authorities are the second most common authority with the responsibility for checking compliance. If energy performance requirements are part of a broader building regulation, responsibility to check compliance with energy performance requirements will more often lay with the community, as they are also responsible for building permits and compliance with building regulation. A few MSs appointed a private organisation to check compliance.

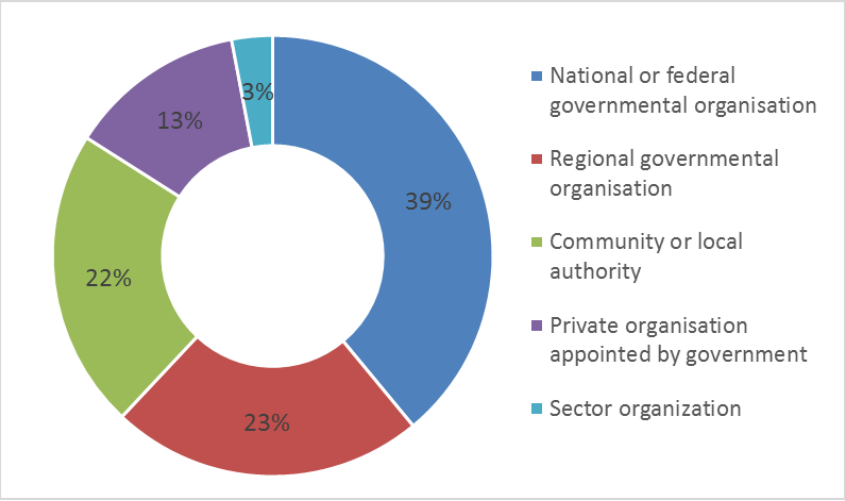


Figure 1. Type of organisation in charge of enforcement of energy performance requirements.

When communities and local authorities are in charge of building regulations, there are two possible barriers that can impede smooth operation. The first is that, due to limited personnel, they often do not have comprehensive knowledge of energy performance regulations and calculation methodology. Proper training and smart instruments through which compliance can easily be checked are key to achieve success. The second possible problem is that local authorities can have different enforcement priorities. This can lead to wide variations in the enforcement of the energy performance requirements between communities. Solid agreements are necessary in that case in order to achieve comparable enforcement efforts.

2.5 When to check compliance

There has been significant evolution in the way MSs check compliance with new building regulations. While checking the building in the design stage was the most important check in the past, the majority of MSs now carry out a double check:

- At the design stage, fulfilment of the requirements is checked for the first time. This check is essential to be sure that all measures necessary to reach a certain energy performance level are foreseen in the construction specifications. In 2014, 19 MSs checked compliance of the building permit and one more checked compliance before construction began. Not every MS asks for proof of compliance with the building permit, as all data necessary for the energy performance calculation are not necessarily available at that point.
- When the construction phase is finished, a second calculation and compliance check is foreseen. This second check is crucial to be sure that the building, as it is built, complies with the requirements in the regulation. Experience has shown that buildings are not always constructed as originally designed. Developers or builders often change some details or components that can influence the energy performance of the buildings. In 2014, 21 MSs checked compliance at a certain moment after construction was complete. This check can be linked to approval of a permit to use the building, but is also possible without that link.

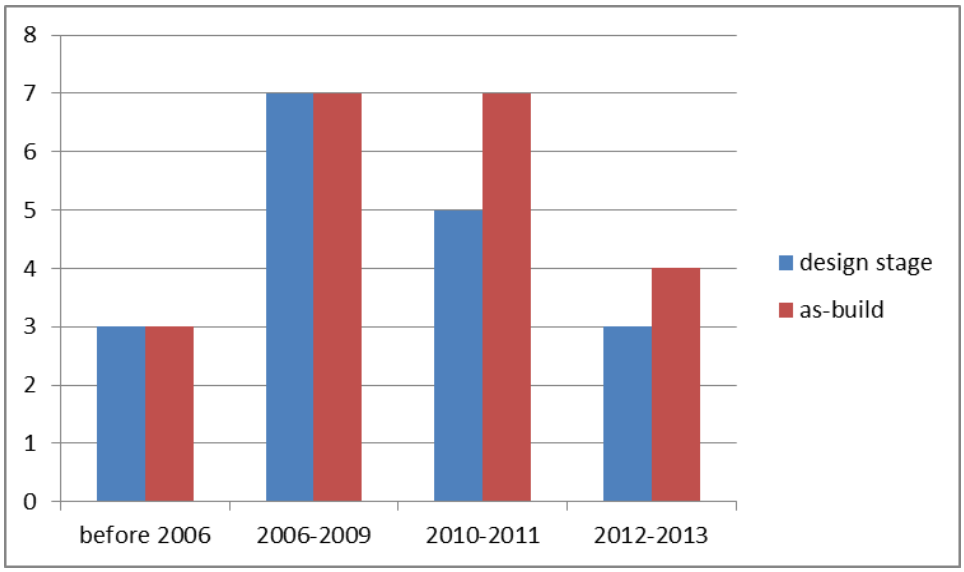


Figure 2. Number of MSs that began checking compliance with energy performance requirements in the design stage and in the as-built phase, until 2013.

A number of MSs' regulations foresee the possibility to control on-site during the construction phase. This check is in practice always at random. During the inspection, building control officers can check consistency of the building with its design, or determine solutions applied in practice, to compare them with the as-built calculation afterwards.

Prohibiting changes between the design stage and the as-built situation is in practice impossible. Some MSs ask for notification of all changes to the initial design at the end of construction.

Checking compliance with requirements after the construction phase is necessary as most building projects change between the planning phase and the construction. Checking compliance in the planning phase is required to be sure all necessary provisions are foreseen before the construction starts.

2.6 Controlling all buildings or only a sample?

Most MSs check the compliance of every building in the design phase. In the as-built phase, many MSs do only a random check. The at-random check sometimes consists of a check of all requirements for the building, while in other MSs it consists of a check of one or a few specific requirements.

It is clear that with at-random checks of compliance, the likelihood of being controlled can be very low. The low probability of being controlled can lead to a sense that the fulfilment of the requirements is not important at all.

It seems inappropriate to do only at-random checks for the global energy performance requirement. It can be done for other requirements (e.g., possible specific airtightness requirement), as long as the at-random sample shows very high compliance rates. But in this case, the stricter the requirement, the less appropriate an at-random check seems to be.

If some requirements are controlled on an at-random basis, the builder should never know that he will be controlled when starting this building construction.

Systems that check the compliance of every building with a requirement function best. With at-random checks, the chance of being controlled and get sanctions can be so low that builders do not care about these requirements. Real - as built - compliance levels can be low in that case.

2.7 Instruments used to check compliance

2.7.1 Energy performance calculation and software

The calculation methodologies for new and refurbished buildings are described in national/regional legislation or in a national standard. Some MSs impose the use of a specific software for the calculation of the energy performance of new and refurbished buildings. Other MSs have a free market for software, and they validate or approve the different options available.

The first step to check compliance is a check within the software. The software gives quick feedback to experts and builders. The software check makes it possible to indicate compliance with the requirements in documents or files generated by the software. If the sanctions are fines, it is a good idea to immediately calculate the fine for a non-compliant building project. This is useful information for the expert and builder, and it can also be a step towards smooth functioning of the sanction process.

The first step to check compliance is a check within the software that enables quick feedback. It also makes it possible to indicate, through generated data, if the building meets the requirements or not.

2.7.2 The Energy Performance Certificate

Every new building needs an Energy Performance Certificate (EPC). The EPC must be handed over to the building owner or the tenant. As the EPC should contain reference values, e.g., minimum energy performance requirements, it is possible for the building owner or tenant to easily assess compliance with requirements. If MSs have other requirements, e.g., for ventilation rates or indoor climate, it is useful to also indicate compliance with those requirements on the EPC for new buildings. This enables the building owner or tenant to see the whole picture.

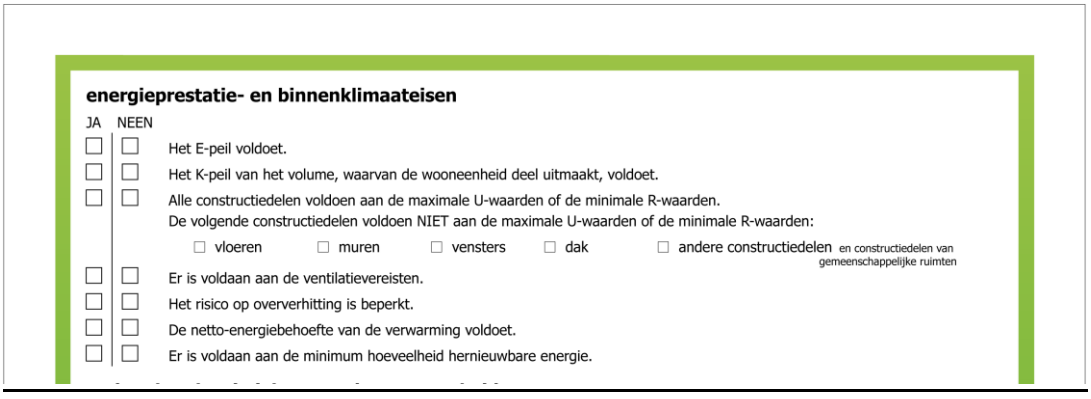


Figure 3. Example of part of the EPC of a new building where compliance with energy performance requirements for a new building is displayed (Belgium - Flemish Region).

Annexes to the EPC or other documents (e.g., an 'Energy Performance-declaration') can contain more detailed information. This detailed information is of great value because:

- it provides information on which solutions (insulation, airtightness, etc.) are really installed;
- it can be used to reissue a certificate, when required after ten years, or when the building is renovated;
- it allows the interested builder, tenant or owner to check conformity of the EPC with the actual building.

Some MSs use a provisional EPC in the design phase. This has an advantage in the real estate market whereby new buildings that are being sold before they are constructed have an EPC comparable to that of existing buildings. However, a very clear indication of the building's provisional character is required: as indicated before, buildings are often not built as planned. Changes can influence the energy performance and thus the final EPC of a new building.

If the same software can be used for building regulation compliance and for producing the EPC of new buildings or major renovations, the same Quality Assurance (QA) scheme can be used to control the experts. In some MSs, the EPC is used by the building control officers to check requirements.

The EPC of a new building should contain an indication of whether or not it meets (all) energy performance requirements. Provisional EPCs in the design phase offer an advantage in the real estate market.

2.7.3 Other documents

Some MSs do not use the EPC as proof that a building meets the energy performance requirements. They use other forms, such as:

- specific forms that are added to the application file for the building permit;
- a specific form on energy performance when construction begins: a 'declaration of the start of work', which includes the energy performance calculation according to the design phase;
- specific forms in the as-built phase to demonstrate that the building complies, e.g., an 'Energy Performance declaration'. In some MSs, the EPC for a new building is part of the 'Energy Performance declaration' in the as-built phase.

2.7.4 Central database

Many MSs have developed a central database for EPCs or for energy performance calculations of new and refurbished buildings. A central database makes it possible to build an efficient compliance checking process and system, because the body responsible for enforcement then usually has direct access to all information about the buildings that do not meet requirements. This reduces the administrative burden and the administrative cost for running the compliance checking system.

Some MSs restrict their database so that buildings that do not comply cannot send in their result, and thus do not receive an EPC. MSs should think about this option very carefully, as it could trigger fraud: when the building does not meet the requirements, the expert can simply produce a false calculation that complies with the regulations in order to obtain the EPC.

Ireland is setting up a new database for new buildings, which will contain even the as-built plans. When a lot of information is available in the database, it is easy for building control officers to access this information and check compliance.

Information about the compliance of new and refurbished buildings with requirements in a central database enables an efficient enforcement scheme and monitoring of the compliance rate.

2.8 The link between compliance with requirements and quality control

2.8.1 Reliability of calculations – the independent quality control system

The link between compliance checking and the independent quality control system is crucial. Compliance checking systems implemented by the MSs are designed to guarantee compliance with requirements. Quality checking is needed to ensure compliance of the calculation in the software with the actual building. If the actual building does not meet the requirements, there is a risk of fraud. In order to avoid a sanction for non-compliance, developers or builders can put strong pressure on experts to lie about the measures that are really implemented in the buildings.

Energy performance calculations of new and refurbished buildings should be 'reliable', reflecting the actual, as-built situation. MSs can implement three provisions to maximise reliability:

- The first provision is to ask for a calculation during the as-built phase.
- The second provision is to include appropriate penalties for experts in the legislation, in case of untruthful reporting of the real energy performance. Setting these penalties on a similar level as the sanctions for non-compliance with the requirements can strongly encourage the experts not to take the risk.
- The third provision is to perform enough checks on the quality of the energy performance calculations of new and refurbished buildings (through the EPC or an equivalent instrument). Therefore, the compliance of new and refurbished buildings with requirements should be addressed in a separate 'statistically relevant' sample.

The result of quality control of the calculations of new buildings in one MS showed that, in 80% of the cases, the reported result was in line with the actual building performance. MSs should pay special attention to control the quality of the calculations of buildings that have an energy performance close to the requirement levels. Mistakes or false reporting can lead to calculations that comply, while in practice the building does not comply.

Checking the quality of energy performance calculations of new and refurbished buildings is necessary to avoid fraud in buildings that do not meet requirements. Quality control checks should pay special attention to buildings that are close to the minimum requirement levels.

2.8.2 Reliability of input data

In addition to the quality of the calculation, the reliability of the input data and the quality of the works are also important to establish the correct energy performance of the building. The input data must be reliable to guarantee that the calculated energy performance is in line with the real building.

Where default values are often used for existing buildings, new buildings use detailed information. For some products, experts can use declared values from, e.g., CE marking. The input values needed for other products are not always on CE marking, or may be values for specific conditions, where technical data sheets show all possible conditions. Several MSs have built product databases that provide specific product information to the experts. Examples of these databases are the HARP database in Ireland, the EPBD in Belgium, and the PCDB in the UK.

Some input values are not product characteristics, but, instead, characteristics of the building, e.g., the airtightness. This characteristic is determined by measurement. The measurement has to be performed taking into account a number of rules. Some MSs (France, the UK, etc.) have developed a quality framework to guarantee the reliability of the measured airtightness data, or to build airtight buildings. MSs have varied approaches to guarantee this reliability. The example from France[2] demonstrates that good airtightness performance can be achieved via measurement or by adopting a quality management system through individual contractors. Controls organised by the French authorities showed that the system gives very good results in practice. The experience shows that governmental support in imposing

[2] http://www.rt-batiment.fr/batiments-neufs/etancheite-a-lair/letancheite-a-lair-des-batiments.html

and implementing such quality framework systems is essential to guarantee wide implementation and achieve real market impact. Voluntary quality frameworks are useful, but their penetration rate in the market is generally limited.

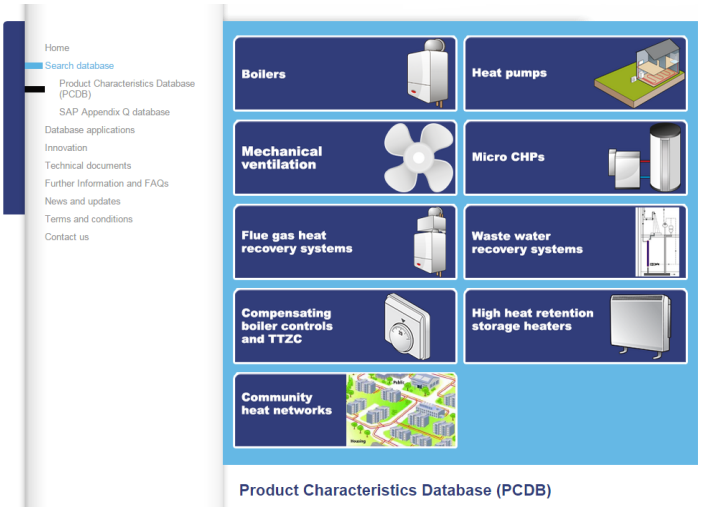


Figure 4. Product characteristics database in the UK (www.ncm-pcdb.org.uk/).

The quality of the works will influence the real performance of the building. It is very difficult to handle this element in a compliance system context. The quality of all the construction works cannot be monitored unless the expert is permanently at the building site. Some MSs integrate a parameter in their calculation method that adds a certain energy loss due to, e.g., imperfect placement of insulation. But the most important element is workforce training, to deliver better quality.

2.9 Barriers to enforce new building requirements in practice

Many MSs face or have faced barriers to developing and operating enforcement in practice. The most important barriers were lack of political support, and the absence of resources to develop, implement and operate the system.

The enforcement system and related sanctions have to run in compliance with national rules. In some MSs, the regulatory framework is incomplete or unclear. This prohibits the practical and efficient functioning of the enforcement system.

Political support is one of the first keys to the success of enforcement. Some MSs experienced that media attention to data and figures on non-compliance with requirements of a statistically relevant set of new buildings or compliance problems in certain buildings could raise political support. Linking the compliance check with financial support mechanisms is another possibility: enforcement is then a control mechanism on efficient expenditure of public money.

Some MSs have put in place a practical and continuous financing scheme (e.g., an expert licence fee, or a fee for each calculation/EPC) for enforcing the requirements and quality control. These schemes require an effective management if they are to overcome the barriers that prevent the implementation of a compliance checking system. A central database which contains an automatically generated indication of the compliance of the building with the energy performance requirements helps to build an efficient enforcement system.

In case the local authorities or communities are responsible for enforcement, training the competent staff is essential. The possibility to check compliance in the software and in the EPC, or another document as part of the building permit process, is of great value when many different individuals are involved.

The regulatory framework related to enforcement and sanctions should be clear and complete. An overview on the non-compliance rate can help to support enforcement in practice. Staff in charge of enforcement need smart tools to carry out their mission.

2.10 Improving the compliance checking system

2.10.1 The time shift

As indicated before (section 2.5), it is important to check compliance with requirements at two points during the building process: in the design phase and in the as-built phase. For residential projects, the time between these two phases can easily be two to three years. For non-residential projects, it can even be longer. So, it can take a long time before the results of changes in the enforcement system become visible. It also takes a long time for a new enforcement system to produce its first results.

2.10.2 A continuous process

Achieving an energy performance requirements system with high compliance rates, and then maintaining or improving the compliance rate, is an iterative process. Some MSs adapted their compliance checking system, other continuously improve their scheme by integrating existing experiences. This continuous improvement can be illustrated by the Plan-Do-Check-Act methodology (Figure 5).

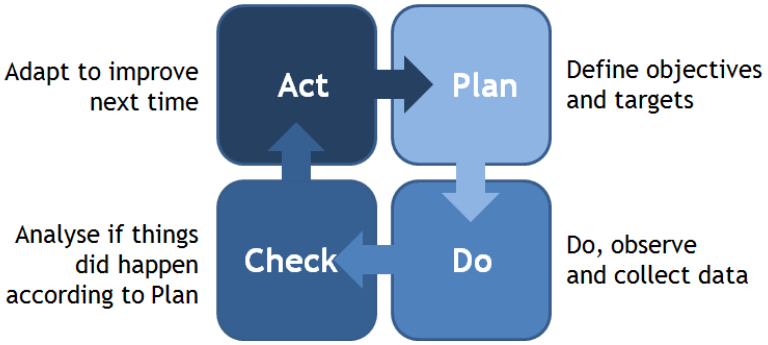


Figure 5. Plan-Do-Check-Act iterative four-step method for the control and continuous improvement of processes.

3 Sanctions

3.1 The role of sanctions

The imposition of sanctions is an essential part of an enforcement system. It is of no use to check compliance if infringements are not sanctioned. Imposing no penalties on offenders is equivalent to punishing those who abide by the rules.

The aim should be to use penalties to react to severe neglect by the builder or developer (compliance checking), or to untruthful reporting of the real energy performance and other severe non-compliances by the expert (quality control). As explained in section 2.8.1, both types of sanctions are linked because there is a risk of fraud regarding compliance with the requirements.

The penalties should be proportionate but severe enough to avoid this behaviour. The penalties process must be clear and simple, both for the administration handling the system, and for building owners and experts.

It is necessary to lay down sanctions to avoid non-compliant builders from being rewarded relative to compliant builders, as non-compliant builders already avoided the investment needed to comply.

3.2 Types of sanctions

Penalties for non-compliance are generally imposed on the builder or the developer.

When the building does not meet the energy performance requirements in the design stage, the most common sanction is not granting the building permit. The design has to be adapted until the building complies.

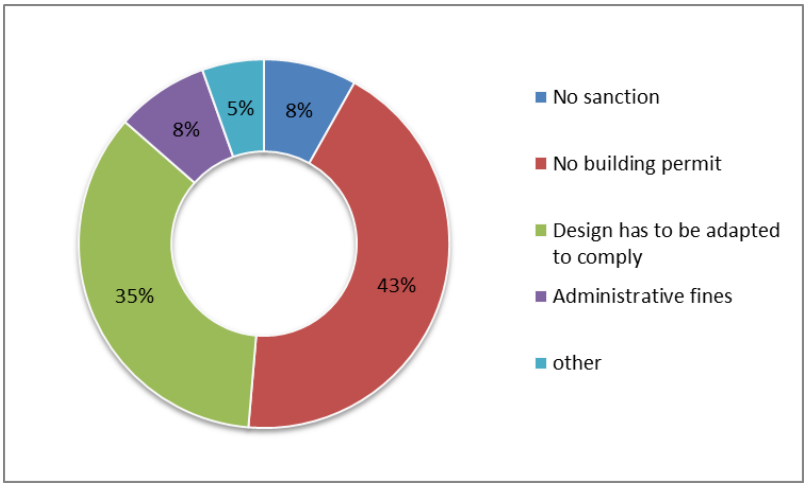


Figure 6. Sanctions in case of non-compliance with energy performance requirements in the design stage.

When the building does not meet the energy performance requirements as-built, the following types of sanctions are commonly foreseen in MSs' regulations:

- prohibition of the building use (with the implied obligation to take extra measures until the building complies);
- obligation to take extra measures until the building complies, within a certain period;
- administrative fines.

It is less common, but a few MSs actually file a lawsuit against those who build in a non-compliant way.

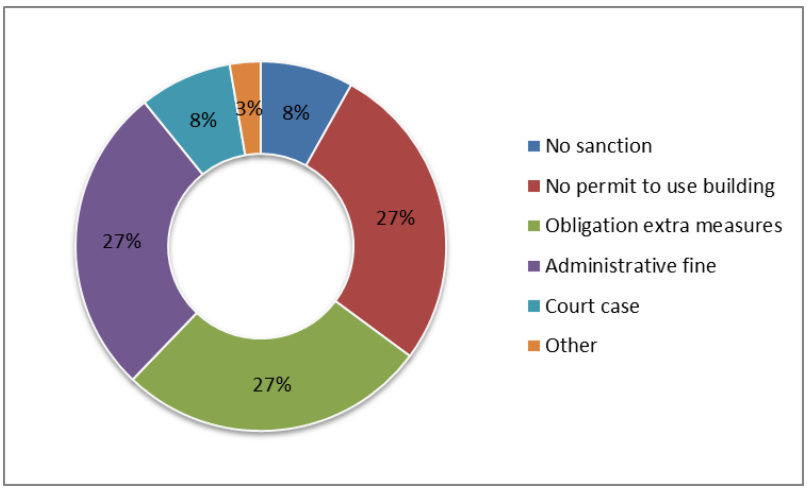


Figure 7. Sanctions in case of non-compliance with energy performance requirements in the as-built stage.

Experiences of some MSs show that the type of sanction has a large impact on the effectiveness of the enforcement and on the compliance rate. In the design phase, adaptation of the project is very effective. Not granting the building permit is a severe sanction that motivates the builder to try to submit a compliant project in the first place, or to adapt it if necessary. During construction, the obligation to take extra measures can also be an appropriate sanction. At that stage, changes to the building are often still possible.

In the as-built phase, the obligation to take extra measures is sometimes not an appropriate sanction. Some requirements (e.g., ventilation rates, or airtightness), cannot be fixed in all cases by implementing extra measures. Improvements can be possible, but not always to the required level. In that case, extra measures cannot 'solve' the problem. In case of lawsuits, some judges assess the offence as less important and do not immediately begin a court case, postponing it until, in effect, its statute of limitations expires. Administrative fines in the as-built phase are easy for the governments to handle and can always be applied.

Some MSs foresee penalties for infringements of the procedure by which the builder must show compliance with regulations. An example of this kind of infringement is neglecting to add the energy performance calculation to the building permit application file, or not laying down the final energy performance calculation of the EPC when the building is finished. The most common sanctions for this type of infringement are administrative fines and not granting the building permit.

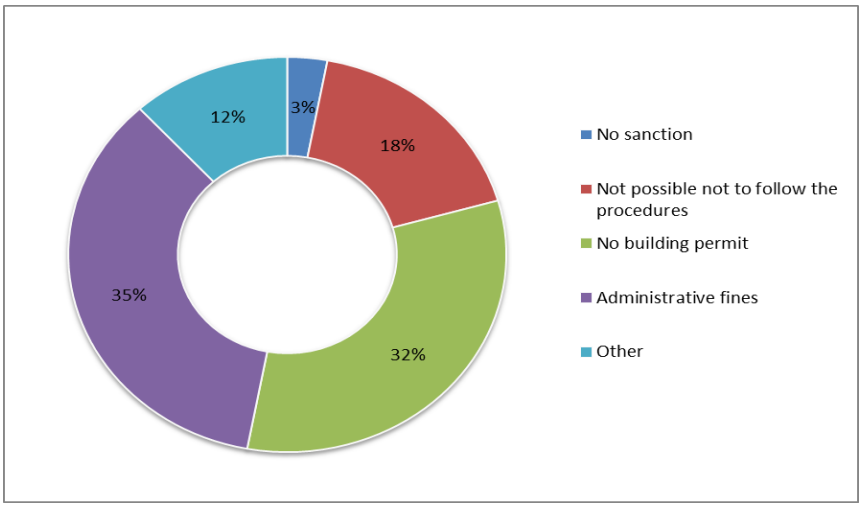


Figure 8. Sanctions in case of non-compliance with the procedure that proves that the building complies with energy performance requirements.

The type of sanction has a large impact on the effectiveness of the enforcement system and on the compliance rate. Some sanctions are not appropriate as penalties for certain infringements.

3.3 Whom to sanction

In most MSs, the builder or the owner of the building permit is responsible for compliance with the energy performance requirements. Some countries have special provisions to protect private builders and buyers of new buildings by appointing the developer or the professional advisors (architect, energy expert) as (co)responsible for the building's compliance.

When, according to the legislation, more than one person is responsible for meeting the requirements, it can become very difficult to impose the sanctions, especially if the control officer has to decide on a case by case basis who is responsible and who has made a mistake. Practical experience showed that these decisions are not feasible for the administration, both on a legal and a practical level.

When sanctions were imposed by the administration on the builder or owner, as the party responsible for compliance, according to the legislation, and the mistake or oversight is clearly the responsibility of the constructor or architect, the builder or owner can in turn ask for compensation from the constructor or architect in court.

Clear responsibilities, imposed on only one person, are necessary for effective enforcement by administrations.

3.4 Proportionate, dissuasive and effective penalties

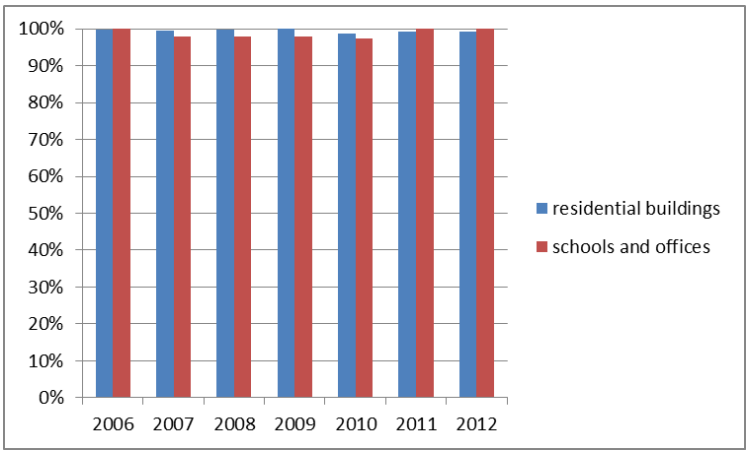
The way sanctions are integrated into the legal framework depends on the national context. EPBD 2010/31/EU Article 27 states that penalties must be effective, proportionate and dissuasive. For a sanctioning system to be proportionate, flexibility is important. For not meeting the requirements, the sanction can be proportionate to the size or the value of the building and with the seriousness of the infringement (the difference between the requirement and the actual performance).

Sanctions and the compliance rate must be monitored to evaluate if the sanctions are indeed effective and dissuasive (see section 4).

Monitoring the compliance rate and evaluating the enforcement system are necessary to determine whether sanctions are effective and dissuasive.

4 Monitoring the compliance rate

Monitoring the compliance rate is essential to evaluate the efficiency of the regulation. A limited number of MSs already have experience in this field. Figure 9 shows an example of the compliance rate of new buildings with the energy performance requirements in the as-built phase in the Flemish Region of Belgium. The Flemish Region lays down administrative fines for infringements of the energy performance requirements. The sanctions are proportional to the difference between the as-built performance and the requirement. The compliance rate is higher for residential than for non-residential buildings. The energy performance requirement for residential buildings was tightened for the first time in 2010. In that year, the compliance rate showed a slight drop.



	Year of the building permit	2006	2007	2008	2009	2010	2011	2012
Residential buildings	Number of as-built calculations	23,524	27,340	25,289	22,872	19,039	12,700	3,552
	Number of buildings that did not comply with the energy performance requirement	26 0.11%	116 0.42%	84 0.33%	22 0.10%	226 1.19%	114 0.90%	29 0.82%
	Requirement for the energy performance	E100	E100	E100	E100	E80	E80	E70
Non-residential buildings (offices and schools)	Number of as-built calculations	264	369	330	297	229	136	63
	Number of buildings that did not comply with the energy performance requirement	0	8 2.17%	7 2.12%	6 2.02%	6 2.62%	0	0
	Requirement for the energy performance	E100	E100	E100	E100	E100	E100	E70

Figure 9. Example of the rate of compliance with the Energy Performance requirement for new residential and non-residential buildings (Belgium - Flemish region)

However, an attempt to evaluate compliance rates in the period 2007-2010 revealed that many MSs did not have a clear view on their compliance rates. From the available information in that period, the level of implementation (number of issued certificates, quality of certificates, changes in the energy performance of the building stock) seemed to be correlated with the enforcement strategy, although there was not yet enough data for conclusive proof.

The knowledge of compliance rates has not improved significantly since 2010. Only half of the MSs indicate that they have a comprehensive picture of the compliance rate of new buildings with the energy performance requirements. In some MSs, this compliance rate concerns compliance with all building requirements (e.g., also fire safety requirements) and is in some cases derived only from a limited sample. Other MSs monitor the compliance rate, but do not publish this information. One quarter of the MSs indicate that they plan to get a view on the compliance rate. The others have no plans in that direction.

In most cases, it takes two to three years between the request for a building permit and the final calculation of the energy performance in the as-built situation. It can take some years before sufficient data is available from the monitoring system for statistically relevant analysis. In Figure 9, the data on applications for building permits since 2009 are not yet complete, as final declarations for these years are still not available.

If information on the as-built energy performance of new and refurbished buildings is not available in a central database, it seems appropriate to analyse compliance rates of a statistically relevant sample. MSs should have target compliance levels. 100 % compliance is not a realistic goal. As in car driving, there always will be persons that are not bothered by sanctions and drive too fast. If the compliance level is lower than the target, evaluation and adjustments to the requirements or the enforcement system will be needed.

It is clear that this field remains a challenge. Knowing the compliance rate is essential to evaluating the actual energy performance level, the compliance with the requirements and the efficacy of the regulation.

In 2014, only half of the MSs monitored the compliance rate with the regulation requirements, some based on a limited sample and with all building requirements (not just the energy performance requirements). As the compliance rate is essential information to evaluate the efficacy of the regulation, this is a remaining challenge in many MSs.

5 Practical experience with compliance checking

Successive assessments of the compliance checking system in place show wide variations in national context and application.

In 2011, some countries did include compliance checks in their regulations, but the sanctions in case of infringements were missing. As a result of the provisions on sanctions in the EPBD 2010/31/EU, there has been progress in the evolution of national legislations since 2012. Compliance checks and sanctions are now foreseen in most MSs' legislations, but there is still a long way to go before a fully operational compliance checking system is in place, with the real imposition of sanctions in case of non-compliance. Some MSs check compliance, but never lay down sanctions, even if the law so specifies. Some MSs check only a part of the requirements, while others check compliance only on a random basis.

Some MSs began checking compliance in the period 2007-2009. Others began implementing the EPBD 2010/31/EU in 2012-2013 (Figure 2). Other MSs were still in the planning phase in 2014. Checking compliance becomes urgent: it is not efficient to tighten requirements when, in practice, non-compliance is tolerated and thus the regulation loses its intended impact. In fact, MSs with less strict requirements but with a very effective compliance system may have better overall results in practice than a MS with very strict requirements and little or weak enforcement.

Experience with as-built compliance checking is not yet the same as with compliance checking in the planning phase. It will take some years to see the results of the changes in monitoring.

6 Conclusions

All MSs should be working towards tightening requirements to comply with the NZEB level by 2021. The more stringent the requirements are, the more important it becomes to check the compliance rate and the efficacy of the regulation to reach the EPBD goals in the best way. To check if a building meets the requirements, a calculation of the energy performance indicators on which requirements are laid down is needed. This energy performance requirements calculation is necessary for every building in the design phase and when the building is finished (as-built).

There are best practices and good examples on how to handle compliance checking. Examples show that strong enforcement leads to a faster adaptation of the construction industry and to further innovation. In a high number of countries, the compliance rate is still not known. It seems that considerable effort is still needed to achieve smart and effective enforcement of the energy performance requirements, as well as a real, as-built, low energy consuming new building stock in Europe.

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