



Inspections

Core Theme 2

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INTRODUCTION

Reducing energy consumption and eliminating wastage are among the main goals of the European Union (EU). They are embedded in Europe 2020 - the EU's strategy for smart, sustainable and inclusive growth. EU support for improving energy efficiency will prove decisive for competitiveness, security of supply and for meeting the commitments on climate change made under the Kyoto Protocol. There is significant potential for reducing consumption. With 40% of energy consumed in buildings, the EU has introduced legislation to ensure that they consume less energy.

A key part of this legislation is the **Energy Performance of Buildings Directive (EPBD)**, which requires all EU Member States (MS) to tighten their building energy regulations and to introduce energy certification schemes for buildings. All MS are also required to have inspections of boilers and air conditioners.

The introduction of national laws that meet EU requirements is challenging, as the legislation has many advanced aspects. It is a great opportunity to further energy efficiency in EU buildings, but also a formidable and continuing challenge for many EU Member States.

To support them in this task, in 2005 the Concerted Action (CA) EPBD was launched by the European Commission to promote dialogue and exchange of best practice between them. An intensely active forum of national authorities from 29 countries, it focuses on finding common approaches to the most effective implementation of this EU legislation.

The multi-faceted format of the forum, with specialist workshops combined with high level discussions, allied to networking opportunities and web resources, has centred on sharing -and inspiring- smart solutions not only for the national legislation and regulations needed for implementation, but also for the professional tools, skills and systems in all fields addressed by it. These solutions are now being applied across the majority of EU Member States.

- **The Concerted Action EPBD** is carried out under the coordination of ADENE, the Portuguese National Energy Agency
- The consortium is composed of organisations appointed by all 27 EU Member States, plus Norway and Croatia

- The activities revolve around meetings, each with over 100 participants, held approximately twice a year
- Working groups and networking take place between meetings
- **Only national authorities implementing the Directive are involved, or those bodies appointed and entrusted by the national authorities to do so**
- Invited experts attend to give additional specialist viewpoints

The 100+ Members of the CA EPBD represent Europe's authoritative, collective knowledge on practical implementation and operational experience of energy performance certification of buildings and inspection and testing of boilers and air-conditioning systems.

When initiated in 2005, most MS were still at the planning stage, but are now well advanced. After stimulating advancement and convergence across the EU, the CA approach was further elaborated in 2007. The MS now share real operating experience and the Concerted Action provides ever increasing practical value and deeper learning to all participating authorities, playing its role in ensuring the success of this Directive as a vital instrument of EU energy-efficiency policy.

The CA EPBD 2 (2007 - 2010), the outcomes of which are presented in this book, is organised around 5 Core Themes (CTs):

- **Certification of Buildings**
- **Inspections of Boilers and Air-Conditioning systems**
- **Training of Experts**
- **Procedures for Characterisation of Energy Performance**
- **Information Campaigns**

Since its second phase was launched in December 2007, it has organised six major meetings between MS representatives, with intensive preparatory work in between. In addition to plenary sessions devoted to issues of general interest, it organised a total of 63 detailed technical sessions for discussing specific issues relating to one or more of the 5 CTs. Some sessions were organised in collaboration by two or more CTs, in topics that had impacts on various issues. The discussions built on the knowledge from the eight previous meetings, held during the period 2005-2007.

The initial plan for the CA EPBD 2 included a long list of topics related to the various Core Themes and additional topics have been identified by the participants since its launch. A brainstorming session at the first meeting in December 2007 was very useful in defining the topics of interest for the MS to discuss in the coming years. Furthermore, the recast of the EPBD was launched and adopted during this period, the CA being instrumental to that process.

The second part of this book contains extended summaries of the main outcomes of each of the 5 Core Themes, including conclusions and recommendations. The objective of the reports on the Core Theme activities is to present a snapshot of the concerns and deliberations of the teams dealing with practical implementation of legislation at national level. The synoptic information presented in these thematic reports is taken from dialogue during the period 2007 - 2010. Some topics may not have been revisited since the earlier part of that period and, as such, the results may be representative of that point in time. Nevertheless, the pros and cons of different approaches to implementation of the Directive remain relevant. For details on the present situation in all countries, i.e. in the final quarter of 2010, please see the Country Reports, part three of this book.

The CA EPBD is supported by [Intelligent Energy-Europe](#) under the [European Union's Competitiveness and Innovation Programme](#).

1. General Information

Since its launching in December 2007, the CA EPBD 2 (2007 - 2010) organised six major meetings among Member States representatives, with intensive preparatory work in between. In addition to plenary sessions devoted to issues of general interest to the 120+ participants at each meeting, it organised a total of **63 detailed technical sessions for discussing specific issues relating to one or more of its 5 Core Themes (CTs), 23 of which were devoted to topics covered by the Inspections theme.** Some Inspection sessions were organised in collaboration with some of the other Core Themes. Inspections have been a topic of novel interest for most Member States during this period, due to the low level of implementation till 2007 in most MS, allowing participants to learn a lot from each other during the sessions.

Building on the experience from the CA EPBD (2005-2007), the initial plan included a long list of topics related to inspections of boilers, heating and air-conditioning systems; additional topics have been identified since then by the participants. A brainstorming session at the first meeting in December 2007 was very useful in defining the topics of interest for the Member States representatives to discuss.

This report summarises the main outcomes of these Inspection sessions, including conclusions and recommendations.

2. Programme of Work

2.1 Description of the action “Inspections” in CA EPBD 2

According to the EPBD (Art. 8), Member States must implement mandatory inspections of boilers and air-conditioning (A/C) systems, above certain threshold power levels, depending on type of equipment or fuel, as well as of heating systems when older than 15 years, and produce recommendations for upgrade or substitution in certain cases. With millions of such units everywhere in Europe, this is a task that might prove even more challenging than implementing certification of new, existing and public buildings, by the simple force of the very large numbers involved. For boilers, an option is offered: to implement, instead of inspections, information and advice campaigns having at least the same impact as inspections.

2.2 Identifying the activities

Within the CA EPBD 2, MS took the opportunity to discuss the logistics and the methodologies involved in these inspections, especially the organisational and financial solutions, the relative merits of inspections versus information campaigns and how to assess their relative success, as well as the costs that consumers will have to pay for this service.

Normally, a number of between 20 and 30 participants have taken part in the sessions. The participants represented many countries, or even all countries in a fair percentage of the sessions, and often countries sent more than just one delegate to certain sessions, in particular when the workshops were organised in collaboration with other Core Themes. The selection of topics was based on an initial list proposed at the first meeting in December 2007, but then other topics of interest were proposed by some participants and the Core Theme leader, according to new needs that were identified as the discussions progressed.

The range of topics for the "Inspections" Core Theme has spanned a wide area: discussion and analysis of EN standards, updating on experiences with boiler inspections and on advice campaigns (Option B according to Art. 8b), methodologies for A/C inspections with the support of the IEE HARMONAC project, updating with actual data and evaluation, combining EPBD inspections with safety and CFC regulations, ways to further motivate users to improve their old heating systems, training of boiler and A/C inspectors, impact of regular inspections of boilers, improvement of inspection schemes, EU harmonised profile for boiler inspectors, interaction between certification and inspections. In detail, the topics raised in the first CA EPBD 2 meeting are the following:

- Specific content of training courses for boiler inspectors.
- Evaluation of energy impact of inspections.
- Equivalence between inspections (Option A), and information and advice (Option B).

- Connecting the two schemes: Inspection of Heating and Air-Conditioning systems, and Energy Certification of buildings.
- Interactions between the Energy Services Directive and EPBD.
- State-of-the-art for air conditioning components, to allow inspectors to recommend the best alternative solutions using updated databases of available technology (e.g. the EUROVENT database, extended in 2006 by the IEE project AUDITAC).
- Comparative presentation of national legislations implementing EPBD's Articles 8 and 9 throughout MS, in connection with core theme training, to include Art. 10.
- Connection between EPBD inspections and fluorinated gas checks, and between EPBD and gas safety inspections.
- Generation of advice from inspection, including cost-effectiveness issues, production of software and experiences from MS.
- Information to end users - connection with information campaigns.

3. Activities under the Inspections Theme

The work in the "Inspections" Core Theme included most of the topics listed in the previous section. In all the sessions, there have been a total of 65 presentations, ranging from presentations of the state-of-the-art to discussion of specific problems, from almost all the MS taking part in the Concerted Action.

The many different types of inspection schemes and the adoption of Option A or B of Article 8 of the EPBD led to the fact that some approaches might be suitable for some kinds of situations or some types of buildings, while impossible for others. As an example, so-called pre-inspections on air-conditioning systems could be sufficient in most cases, but for complex A/C systems (such as in hotels), a full inspection procedure (including pre-inspection) would be necessary.

The main issues addressed by the Core Theme were grouped in two areas:

A. Development of methodologies for inspections

- Boilers and heating systems: inspections, information campaigns, or both?

Both approaches are acceptable under the EPBD. Participants representing MS that have already decided to opt for one or the other, presented their approaches and, when available, their previous and current experiences.

The consequent issue was the comparative evaluation of effectiveness and costs of inspections and information campaigns. The analysis of the two approaches led to the presentation of possible methods to assess their impacts on energy efficiency, even if a common conclusion is far from being determined, and the discussion remains still open.

- Regular inspection of air-conditioners - too expensive with respect to the achievable result?

The new CEN standard "EN 15240 Inspection of air-conditioners in buildings" includes many checks and requires significant time, even if it is not able to quantify the energy performance of the system. Are there alternative solutions?

B. Implementation of inspection schemes

The organisation of an inspection scheme involves several complicated issues, such as selection of inspectors, costs of inspections, registration of results, identification of boilers or A/C systems to inspect, the authority for quality assurance and control, and so on. Which are the most cost-effective solutions, allowing the use of existing skills, traditional schemes, service personnel contribution, and minimising the use of public structures, bureaucracy, direct or indirect burden to end users?

In the following sections, the details of the issues for each of these topics are described.

3.1 Development of methodologies for inspections

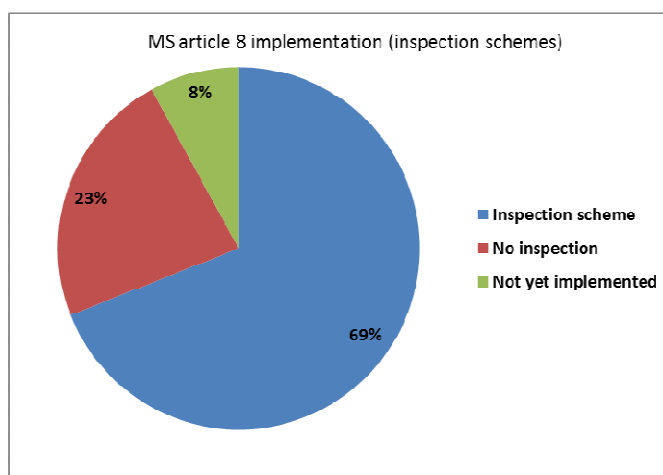
3.1. Article 8: Option A (Inspections) or Option B (Campaigns)?

Evaluation methods are necessary in order to clearly define if advice/information campaigns (Option B in EPBD Art. 8) are as effective as inspections (Option A).

On the basis of a questionnaire answered by Concerted Action participants in December 2008, the quota of MS having selected option B is 20%, whilst 30% have selected to some extent both options A and B. Out of 26 responding MS, 18 have decided to implement an inspection scheme, 6 have decided to use option B, and 2 are still uncertain.

An unexpected trend was identified during discussions: several MS have decided to implement combined solutions, mixing somehow information campaigns and inspections. Examples were reported of inspections or pre-inspections accompanied by a user-targeted information campaign, or an information/advice campaign supplemented by voluntary inspection schemes.

Many MS have therefore decided to move from a rigid definition of the two approaches to a more flexible, combined approach, using the most effective elements of both, with the objective of improving the energy efficiency of the systems in mind. A possible way to improve the impact of inspections, combining it with other measures, would be to include some relevant mandatory requirements, which should be implemented in case, for example, of old boilers, or un-insulated pipe works, or lack of central climatic controls and thermostatic valves. Another proposed option is to provide the user with a calculation of the seasonal energy efficiency of the whole system, and offer a benchmark in respect to the most advanced technologies. This could provide a powerful motivation for renovation of the system and improvement of energy efficiency.



Results from the inquiry on 26 MS on Art.8 implementation (2008)

In most of the countries, cost plays an important role. Other effects, like emission reduction, reduction of energy demand or avoided CO₂ emissions have different weight in MS approaches. Some MS demonstrated that their choice was the most cost-effective, even if their opinion has changed from a previous approach. In general, the cost-effectiveness of an approach has to be substantiated by an evaluation of the impact in energy efficiency improvement, as the simple verification of a correct maintenance of boilers or air-conditioners does not justify the effort of setting up an inspection scheme. There is a widespread agreement among MS that, while inspections of larger installations are clearly cost-effective, inspections of smaller units, option A, especially in moderate climates (low heating or low air-conditioning loads), are clearly not cost-effective.

Another experience stresses that inspection and provision of advice should be provided not just for boilers using non-renewable liquid or solid fuel, but to all kind of boilers, including those burning biomass. One MS suggested the estimation of the benefits of using renewable energy sources for heating, according to the suggestions of the Directive 2009/28/EC on the promotion of the use of energy from renewable sources. The discussion continued on how this will affect the current implementation and what the benefits are of including all kind of boilers. 11 MS declared to have considered the influence from other

EU Directives for the implementation or for developments further than those required by the EPBD. Of those, 5 have considered Directive 2005/32/EC for establishing a framework for the setting of ecodesign requirements for energy-using products. Most of them mentioned definitions and standards, others considered Directive 2006/32/EC on energy end uses and energy services, as Article 8 of the EPBD mentions the reduction of energy consumption as the main objective.

MS that have chosen option B must submit **reports on the equivalence of the Option B approach**. Therefore, they were particularly interested in defining a method for assessing the impacts of the two approaches.

Ten countries have considered measuring the performance impact of inspections/information campaign, as well as the estimated expected impact. As there was no exact answer on how to measure this impact, some possible survey-based methods were suggested, together with suggestions on how this impact could be defined in official statistics. Even though the MS which have chosen option A do not have to submit such reports, information on cost-effectiveness and anticipated energy savings will be very important in order to define the policy implementation features. A synergy may therefore exist between those two kinds of reports.

A study performed in an Italian region (Florence) after some years of implementation of an inspection scheme, gave interesting results: based on a sample of roughly 134,000 inspected boilers, the frequency of detected anomalies/defects in the systems was calculated (un-insulated pipe work, absence of thermostatic valves, low generator efficiency, etc.). Then the potential improvement of the seasonal system efficiency for each defect type was estimated, for two different scenarios: A = standard solutions according to legislation in force, B = applying the best available technologies, obtaining a potential energy saving from 45.9% to 68.4% respectively in case of scenario A, and up to 81.3% in case of scenario B (correcting the worst case, where all the most common defects show up). Applying the potential improvement related to each defect type to the frequency of occurrence of the same defect, the authors obtained a potential improvement of the overall energy efficiency for the whole sample of between 4.5 to 6.5%. This study implies that the inspection is able to analyse the whole system and not just the boiler, and that the inspector is able to provide reasonable advice, so that the owner is convinced to invest in energy efficiency or to modify his/her behaviour regarding the use of energy.

One tool developed in a MS in the framework of Option B was considered really promising and interesting: it concerns a voluntary one-off inspection of old boilers. The system is based on a computer tool (excel sheet) consisting of a checklist which automatically generates advice. It can be adopted as a kind of a voluntary inspection-based advice scheme on heating and air-conditioning systems. A recent survey has been carried out on this scheme, showing, for example, that the most known energy efficiency tool in the country was the energy labelling of buildings (87% of the sample), while the awareness on this voluntary inspection was only 32%. This demonstrates that people are less informed about inspections than about building energy certification. This is a further example of how MS efforts in this direction are still at an initial stage.

National authorities have had a large influence upon the introduction of Option A or B. Other organisations such as inspectors, advisors, building owners associations, politicians, as well as installers and maintenance service associations have had any influence only in five countries. For a successful implementation of the EPBD, and especially for the introduction of inspection or the provision of adequate information, it is very important that building owners understand the measures and the possibilities of achieving cost-effectiveness and energy savings.



It is recommended that MS consider the adoption of a combined approach, using the most effective elements of both inspections and measures for provision of advice, having in mind the objective of improving the energy efficiency of the systems.

3.1.2 Drivers motivating voluntary inspections

One of the most important questions connected to inspections is “What are the reasons and the most successful tools, schemes, projects and policies within Member States -both local and national- motivating users to improve or replace their old heating systems (boilers and the main components of the system)?”.

The following main policy tools were considered:

- Tax Credits & Incentives
- Info Campaigns
- Obligation to substitute components + Support for low-income users
- Information/training for installers

Other successful experiences on implemented measures were pointed out:

- Contracting more efficient systems for social houses (rented multifamily buildings).
- Allowing higher rental fees after renovation.
- Supply contracts related to quality.

Successful experiences have shown that some specific drivers have fostered the improvement-replacement-retrofitting of old heating systems, such as:

- Information and advice (campaign on oil boiler substitution).
- Overcoming institutional and regulatory constraints.
- Banks-ESCO agreements that facilitate the overcoming of the financial barriers.
- “All inclusive” energy services.
- Refitting evaluation (is the proposed intervention actually cost-effective?).
- Inspections providing also advice.
- Incentive programmes (an example from one MS shows that new boilers covered 31% of all energy tax-credits, which produced globally an impact on energy consumption of -0.3% in one year).

The key elements of success in order to persuade users to retrofit their heating systems can be summarised as follows:

- Information provision (energy education of owners, tenants, staff and management).
- Targeted programme marketing.
- Thorough energy and cost analysis.
- Technical assistance in retrofit planning, including supervision of bidding and contractor work.
- Awareness on performance standards and other regulatory tools.
- Timely information on financial incentives.
- Effective procedures (internet-based) for monitoring, evaluation and follow-up.

Valuable experience regarding effective approaches to improve energy efficiency in buildings has been gained through the efforts of local, state, utility, and regional programmes.

An example of information campaigns connected to boiler inspection was described by one MS, where the campaign promoted actions requiring just a small investment, such as:

- Heating pumps with electronic volume flow control.
- Proper pipe insulation.
- Hydraulic adjustment of heating systems.
- Proper settings of central control units.
- Advantages of modern boilers.

Furthermore, the National Heating Association stipulated an agreement with all its members, convincing them to participate in a PR-campaign, where advice was provided by heating installers. This campaign also promoted the heating system inspection by advertisement and by direct contacts between members and customers.



Marketing of the inspection scheme, provision of information, technical assistance, training, performance standards and ratings (mandatory or voluntary), as well as financial incentives, must all work together in order to significantly improve energy efficiency.

3.1.3 The CEN Standard for A/C inspections (EN 15240)

Member States need to understand how to best use the EN 15240 standard in the national transposition of air-conditioner inspection (as required in art. 9 of EPBD). As reported by the head of the technical committee that produced EN 15240, Jorma Railio, this standard has been expressly designed to leave a fair margin for national differentiation, just as the EPBD leaves freedom for national adaptation in inspection frequency and extent. In fact, various interpretations of the standard have been identified, and even some basic terms seem to have been interpreted differently from country to country. For this reason, some points of the standard need to be revised, some of its basic terminology subject to misinterpretation needs to be clarified, and some classification may be introduced:

- Definition of an "air-conditioning system": what does it include exactly? Art. 2 of the EPBD defines an air-conditioning system as *a combination of all components required to provide a form of air treatment in which temperature is controlled or can be lowered, possibly in combination with the control of ventilation, humidity and air cleanliness*. The adverb "possibly" introduces ambiguity. This has been redefined in the recast Directive.
- Definition and applicability of the 12 kW threshold: should there be a unique definition of the limit or, instead, should there be an adaptation of the limit to the specific building, zone or unit? (One MS has taken the decision to sum up all installed devices within a building.) The recast Directive has specified that the limit applies to system size.
- Definition of the background of a "qualified expert".
- Clarification of the meaning of "self-inspection", mentioned in Annex C of EN 15240, as part of the recorded material to be checked by the inspector.
- Many arguments came out in favour of extending the inspection to always include ventilation, when part of the A/C system. Due to the constant improvement of building insulation (towards very high performance levels), and the shading of glazed areas, ventilation will soon represent the main source of overall energy consumption.
- Classes are also included in EN 15239. There is a possibility to combine the inspection with an energy audit and/or an indoor air quality (IAQ) audit. MS do need more guidance, as the legislation is new for most of them.
- Does the methodology apply to existing buildings as well as to new ones? Existing buildings may not have maintenance records available, and documentation may be incomplete, outdated or even lacking. The first inspection will be important in order to put the system improvement on the right track!

It is necessary to gather feedback from in-field experiences. Some actions (e.g. the IEE project HARMONAC), have strongly contributed towards that goal.

There is at present no method defined in the standard for the assessment of the efficiency of the whole A/C system (from outer air inlet to air supply to the room). **A revised standard is strongly needed.**



EN 15240 leaves a large margin to MS implementation, and it needs to become more precise and targeted, with better definitions and A/C inspection methodologies.

3.1.4 Cost-effectiveness of air-conditioner (A/C) inspections

Following the successful completion of the project “Field Benchmarking and Market Development for Audit Methods in Air Conditioning - AUDITAC”¹, on the inspection and auditing of air-conditioning systems, analysed during a meeting in 2007, MS discussed in detail the results and proposals of the IEE project “HARMONAC²: “Harmonising Air Conditioning Inspection and Audit Procedures in the Tertiary Building Sector”, presented by its coordinator, Prof. Ian Knight.

There are strong needs for making A/C inspections more cost-effective, as the required time for an inspection performed in full accordance with EN 15239 can be from several hours to some days. Previous discussions in the period 2005-2007 indicated that “while inspections of larger installations are clearly cost-effective, inspections of smaller units, especially in moderate climates (low heating or low air-conditioning loads), are clearly not cost-effective”.

However, HARMONAC concluded that there is significant scope for energy savings in A/C inspections, but it may be not necessary to have detailed inspections and tests for all systems. It is thus necessary for an effective A/C inspection scheme to allow identification of the systems which are consuming too much energy. There is a range of options which allow A/C inspections to be simple and not expensive, without losing the majority of the energy efficiency benefits. One of these options includes introducing a “graded or step-by-step” inspection scheme on air-conditioning systems (pre-audit, inspection, audit, advice):

- **Pre-inspection:** checking building type and use, A/C system type, consumption, maintenance records, etc. It can be undertaken by personnel without specific A/C skills. The aim is to establish whether there is a potential problem before visiting the system, and to focus the visit on those areas that need attention during the inspection.
- **Inspection:** includes the work already undertaken during the pre-inspection, and should establish, through a visit to the system and some quick and simple measurements, an overall energy performance evaluation and an indoor air quality status for the system.
- **Audit:** involves the detailed analysis of an A/C system when its inspection has indicated unacceptable performance in one or more areas. This may involve more specialist checks that are normally outside the competencies of an inspector to undertake.

The main point of interest is the adoption of a pre-inspection, where analysis can be based on the data provided by the owner through the service personnel, which could be upgraded with appropriate analysis tools, mainly software tools. A combined condition is to have a dedicated electricity meter, measuring the energy absorbed by the A/C unit alone, and benchmarking values, coming from a wide and multinational sample of monitored systems. The main advantage of this approach is that the following step, the on-site inspection, could be limited to only those systems having a performance far lower than the benchmark and, therefore, having a high energy saving potential. It is however controversial whether this simple analysis could lead to reliable advice and solutions. A good compromise could be represented by the adoption of pre-inspection schemes for simple buildings on one hand, and detailed audits for complex ones on the other.

The full set of HARMONAC outputs is now available. For those MS which are still in the implementation phase of the appropriate regulations, it would be worth analysing the different approaches and experiences from the project. It would also be worth comparing benchmarking values from different studies and methods in comparison with actual building consumption data.

¹ AUDITAC Intelligent Energy Europe - IEE project number EIE/04/104 <http://www.cardiff.ac.uk/archi/research/auditac/>

² HARMONAC, Intelligent Energy Europe - IEE project number EIE/07/132 www.harmonac.info

3.2.2 Boiler and A/C inspector training, and a possible harmonised profile for boiler inspectors.

From information collected in 2009 from MS where inspector accreditation is running, the following main conclusions were obtained regarding the contents of boiler and A/C inspector training courses:

- Four MS started training A/C inspectors.
- Seven MS have set but not started specific training or are envisaging specific training of boiler inspectors only.
- In one case, a common training is supplied for certification and inspection experts.

The bodies providing training within various MS may be far different:

- professional associations
- public institutes
- energy agencies
- universities
- training companies

Usually, the MS involved in training are those that have established an accreditation system for inspectors. Typical training courses take from 5 to 10 days and require a final examination. The main topics delivered are common to every country: i) safety of gas boilers, ii) inspection procedures, iii) energy efficiency improvement opportunities, iv) drafting of recommendations.

Subject	Nr. of hours
Legislation and basic theory	16
Fuels and combustion	8
Heating systems for buildings (efficiency + safety)	4 + 12
Measuring instruments	4
Technical standards for inspection	4
Practical experience on inspections	16

Example of structuring a training course for boiler inspectors

On the contrary, the background level of qualification of inspectors is far different, spanning from skilled workers (for example chimney sweepers) to thermal engineers, reflecting a diversified approach to the quality and level of the depth of inspections, having a clear connection with the expected costs for the end users.

It is common understanding in the MS that it is not necessary to have a separate training and qualification scheme for the inspection of boilers and the inspection of the whole heating system, neither for commercial nor for residential buildings, as the basic skills are the same. It is not known to what extent the training for basic skills is already harmonised, though doing so should not be difficult. In practice, it is more likely that installers and maintainers (who may become inspectors) specialise in particular products, even in the products of a particular manufacturer only (especially in the case of boilers).

The structure of the markets for installers and maintainers of heating services has evolved over a long period and would be difficult to change. Unification may be easier for newer types of heating systems, such as pellet boilers, heat pumps, or micro-CHP. There is already some recognition of cross-border skills and methods. European standards such as EN 15378 were thought to be unhelpful in this respect, as they do not deal with the national differences (although the structure of the standard allows for national annexes).

A harmonised profile for boiler inspectors will probably be feasible over a certain period of time, but it is certainly premature at this stage of development. This may be because of entrenched national practices that are difficult to harmonise, or because it is believed that few advantages may be gained from doing

so. Even if inspection is a new requirement in several countries, pairs of neighbouring countries with broadly similar systems and installation practices would benefit from collaboration, and skill shortages in some countries could actually be filled in by others. However, at present, there is no sign that such a move will occur spontaneously.

Similarly, harmonised training on the basic skills of inspectors is hindered by language differences, different practices, and different background qualification levels.



A harmonised profile for boiler inspectors will probably be feasible over a certain period of time, but it is certainly premature at this stage of development.

3.2.3 Advice/recommendation in inspection reports, and interaction with energy certificates

Recommendations can play a positive role, even in relation to heating and air-conditioning systems. The more detailed and tailored they are, the higher the probability that those suggestions will be implemented. Nevertheless, most MS have not yet established an integrated approach for maintenance, inspection and certification processes for existing buildings, and for most of these countries it is quite difficult to integrate these schemes, especially due to the high level of skills needed for professionals involved in these tasks.

The inspection report could include a comparison of the energy performance of the system inspected with the best feasible one available, or with a system of similar type, for which all relevant components achieve the level of energy performance required by the applicable legislation. However, in order to reach this level of recommendation, a suitable method for calculating the seasonal system efficiency starting from data taken during the inspection should be defined.

Furthermore, recommendations for the cost-effective improvement of the energy performance of the system of the building or parts thereof shall be specific to the system, and shall provide clear information as to their cost-effectiveness. The evaluation of cost-effectiveness shall be based on a set of standard conditions, such as the assessment of energy savings and underlying energy prices, as well as interest rates for investments.

Member States shall provide, in particular, information to the owners or tenants of buildings on both energy performance certificates and inspection reports, their purpose and objectives, cost-effective ways to improve the energy performance of the building, as well as mid- and long-term financial consequences if no action is taken to improve the energy performance of the building.

It was agreed that an inspection report should:

- Be understandable for non-technicians (owners and tenants).
- Provide customised advice, suggesting cost-effective measures focused mainly on low-cost investments.
- Compare the actual performance with more energy efficient heating systems, and the existing system type with better technologies (renewable energies, co-generation).

A requirement for an independent control system for the reports on the inspection of heating and air-conditioning systems, i.e. via random sampling checks of the quality, is considered very important. The competent authorities, or bodies to whom responsibilities for implementing the independent control system have been delegated by the competent authorities, should make a random selection of at least a statistically significant percentage of all the inspection reports issued annually, and subject these to verification. The verification shall be carried out at one of the three alternative levels indicated below; each verification level shall be carried out at least for a statistically significant proportion of the inspection reports selected:

- (a) Validity check of input data of the technical building system inspected, which were used for the issuing of the inspection report and the results stated in the inspection report.
- (b) Check of the input data and verification of the results of the inspection report, including the recommendations given.
- (c) Full check of input data of the technical building system inspected, which were used for the issuing of the inspection report, full verification of the results stated in the inspection report, including the recommendations given, as well as an on-site visit of the system, in order to check correspondence between specifications given in the inspection report and the technical building system inspected.

To make this check, it is necessary to create a database on inspected boiler performance in each MS or region. The results of a survey indicated, however, that only 21% of the MS have established a database for boilers, and only 1 MS has established a database for A/Cs.

A natural link between the energy audit and the inspection has been also identified. Guidelines for linking certification and inspection could be summarised as follows:

- Encourage voluntary inspections (as an extension of mandatory inspection).
- Explore the possibility to go, on a voluntary basis, beyond the EPBD in extent and depth.
- Control on inspections: penalty in the case of failure may be a possible way to impose an effective implementation.



Recommendations are an essential part of the inspection, and the inspection report should have the same quality check as certificates, including random quality checks.

3.2.4 Organisational aspects of boiler inspection: combining EPBD requirements with safety and CFC environmental regulations

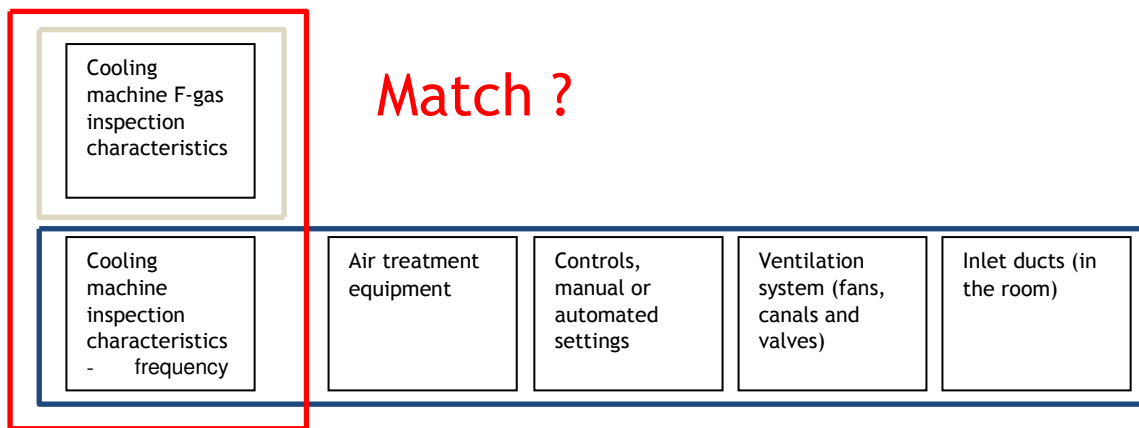
The possible interaction of energy efficiency, environmental and safety aspects in a single operation could limit costs and avoid duplication of checks. The coordination of energy efficiency inspections with other types of inspections is an interesting avenue for keeping the costs as low as possible - even if the objectives of the inspections differ.

In Regulation (EC) 842/2006 on fluorinated greenhouse gases, a number of requirements are put forward to reduce their emissions. There are even more inspections “regulated” by EU, national bodies or even trade associations that may be subject to such coordination. Based on national and European guidelines and regulations, there may be inspection schemes under development for:

- Prevention of uncontrolled bacteriological contamination, including legionella pneumophila.
- Avoidance of radon gas contamination of buildings (for further literature: <http://www.bre.co.uk/radon/>).
- Other possible checks of A/C systems.

The EPBD calls for inspection of A/C systems with effective output above 12 kW, whereas 842/2006 requires that installations containing more than 3 kg of fluorinated greenhouse gases be checked. Both regulations at the European level are presently under more detailed development nationally, but 842/2006 gives less freedom for national legislation than the EPBD. The fact that the two regulations have a different focus and define the target systems differently could be an obstacle if one would strive to have a uniform system. The recommendation for national implementation is to have both regulations in mind when the national rules are defined.

In the formal documents for the two European “regulations”, surprisingly few cross-references exist. An analysis of benefits of coordination should be developed by MS, in order to identify possible coordination benefits, as suggested by the following Figure.



Schematic view of interaction between two different types of in situ checks on A/C systems.

Considerable benefits are available to Governments, experts and system owners, just by coordinating the two schemes. When the combination of the two inspections is enabled through information, enabling individual experts and companies to offer both types of inspections, as well as the proper use and reuse of reported data, the most important is the benefit for the owners, and the possible understanding of the rationale of the public regulation.

Even when the inspection phase cannot be unified, other elements can be commonly operated, such as data collection, expert training and accreditation, definition of inspection frequency, supply of information, and management of the data base. A general recommendation is to make sure that the most frequent inspection collects data which can be also used for other types of inspections, thus avoiding duplication.

Early experiences in some MS show, for example, an attempt of coordination of the non-technical parts of the two regulations (organisation, frequencies, etc.); in another case, there is an attempt of combining EPBD 2002/91/EC article 9 with existing parts of the legislation on air-conditioning. Experiences of accreditation of gas inspectors are also available, and in a few countries a common regulation is already in place. In some countries, an integration of ventilation control and EPBD inspections is applied, while gas safety and energy efficiency are already quite frequently evaluated together during boiler inspections, as well as energy efficiency and polluting emission measurements. It was also acknowledged that differences occur in the required skill level of technicians, making common training more difficult.



The coordination of energy efficiency inspections with other types of inspections is an interesting avenue for keeping the costs as low as possible, even if the objectives of the inspections differ.

3.2.5 Deriving all-season heating efficiency from inspection data

To obtain more useful data concerning the performance of the whole heating system, not just the boiler, it is necessary to also go beyond the instantaneous efficiency usually measured by the flue-gas analysis, towards the determination of the seasonal efficiency, which is more related to the actual impact on energy costs. It is thus necessary to establish a methodology to derive the seasonal heating system efficiency with a simplified calculation, based on data collected during an inspection, e.g., using the calculation method supplied by EN 15316-4-1, knowing seasonal efficiency would help to estimate the seasonal fuel consumption and cost with much greater accuracy. Comparing this with real (billed) seasonal fuel consumption and cost would help to estimate the net energy need and the energy losses.

No single assessment method provides a correct solution for all cases: a simplistic method may not be able to show the effect of improvements, whilst a detailed method may be unnecessarily time-consuming for common situations. The boiler typology method defined in Clause 5.2 of EN 15316-4-1 has proven to be a reliable and easily applied method, suitable for use by people with minimal modeling skills in common situations. The other two methods illustrated in EN 15316-4-1 may be used to determine the values for the typology method; they may be also used for situations beyond the scope of the typology method.

The boiler cycling method, in particular, is meant to deal with existing boilers/buildings (it keeps a connection with directly measurable parameters and allows for the calculation of operating performance of condensing boilers), while the boiler typology method requires the development of a national annex. Case-specific and boiler cycling methods come with annexes (Annexes B and C to EN 15316-4-1), where default values are given to cover a much broader set of cases; adjustments may be required in order to develop a national annex using them as a template.

If no national annex is defined, Annex A provides a limited but complete inspection class set of tables. Nonetheless, it is advisable to use it as an example and/or template for the development of a custom national annex. This inspection procedure is not meant to be a full energy audit or the basis for a complete renovation design. The expected result of the inspection process is an indication of whether there is a reasonable possibility that energy conservation measures could be adopted. Then each improvement measure should be designed and implemented according to local regulations. Many parts of the inspection process are not well covered yet. The intention is to collect experiences and suggestions, and to include them in the next revision of the standard.

A paper was presented, where the all-season efficiency was calculated on a large sample of inspection data³. The assumptions made regarding the influence of the different improvements (pipe insulation, thermal regulation system, chimney status, boiler tuning, etc.) on the average global seasonal efficiency values will probably need a more scientific or a regulation reference basis, but this study represents a gallant attempt to find an application of the boiler inspections in the local energy planning strategy.



Calculation of the seasonal efficiency of boilers and A/C equipment will provide a much more accurate prediction of energy savings, as well as better recommendations.

3.2.6 National minimum EP requirements for technical systems

The EPBD only demands minimum requirements for the building envelope. However, many MS also set requirements for technical systems. A survey (September 2010) showed the following existing requirements, expressing the opinion of a sample of 15 MS participants (% of participants indicated):

- Heating systems: 70%
 - boilers: 70%
 - renewable sources: 50%
- Domestic hot water systems: 80%
 - water storage: 56%,
 - supply temperature: 50%
- Air-conditioning and large ventilating systems: 80%
 - fan: 62%,
 - AHU: 50%,
 - overall system efficiency: 36%
- Lighting systems: 20%
- Metering and monitoring systems: 50%

The minimum requirements of the components of technical building systems and lighting elements are covered by the 2005/32/EC, 2010/30/EU Ecodesign and Ecolabel Directives.

³ D. Parente. Energy saving due to boilers inspections in compliance with the Italian Decree 412/93 and its related further modifications. (In Italian). Magazine “La Termotecnica”, 2004.

The EPBD recast, Directive 2010/31/EU, also asks MS to set requirements for the technical building systems. The requirements of the elements (boiler, pump, fan) cannot replace the requirements of the technical building system. It is still unclear how exactly overall system requirements could or should look like and how they shall be defined, as the system performance depends on the interaction of various components of the building.



Requirements on technical building systems and their parts are essential for the energy efficiency in buildings.

3.2.7 Interaction of inspectors with other market actors

Advantages are expected from the possible wider involvement of the market actors in the HVAC inspections, in terms of participation in local/regional Advisory Committees, in training programme development, and in exchanging information for a better service to the end users.

In most MS, interest is increasing on simplified methods for transforming the role of the inspector from a crude assessor of the present efficiency to a motivator of efficiency improvement. The inspector should be capable of providing useful suggestions on quantitative aspects like possible efficiency improvements and correct/appropriate system sizing. This change of attitude is the key for possible interactions with the other market actors.

The category of maintenance staff can provide good skills, willingness to be trained on technical aspects, strong motivation for possible presentation of offers to the clients. There is in fact a general issue concerning the character of independence in providing recommendations. A careful control of the compliance with the independent recommendation requirement should be committed to a public body by the national/regional implementing body.



The role and qualifications of the ideal inspector is yet open to debate.

4. Main outcomes from the Inspections sessions

From the most recent summaries presented by the participants, it appears that many MS are still at an early stage in the implementation of their inspection approach, especially in relation to A/C systems.

The situation (decision) related to boiler inspection in 26 Member States is (December 2008):

- 70% implement inspections, or are ready with legislation and going to implement soon;
- 20% do not implement inspection schemes, but have selected the “Option B” approach, i. e. the launching of information and advice campaigns.
- 10% are still uncertain on final decision.

The situation for A/C inspections, obtained from 15 participants, updated in October 2010, is as follows:

- 40% do not have new inspection regulations, but can rely on the previous legislation still in force;
- 40% have new inspection regulations published or in preparation;
- 20% do not have any inspection regulation in force.

Differences among MS on inspection schemes, methodologies, type of systems (Heating and Air Conditioning), and training for inspectors are still relevant. Nevertheless, a significant progress has been

achieved with respect to the situation at the beginning of the Concerted Action in 2005. The newly designed schemes have adopted several lessons learned from the more experienced countries; the initial scepticism on inspections has been partially removed, whilst there has been a convergence towards a reduced set of models of application, compared to the initial dispersion of approaches.

Some good practices are coming out already from the early on-field experience of MS having implemented inspection schemes. The countries having a tradition of chimney sweepers' organisations have encouraged these people, already accustomed to visit homes for boiler checks, to verify the boiler energy efficiency, obtaining a quite cheap cost for the end users, as the additional check is quoted at marginal cost. Difficulties have arisen in the attempt to use the inspections for advising the end users on possible system improvements, as the chimney sweepers are often not qualified for delivering this type of recommendations, therefore requiring the appointment of additional or alternative, more qualified personnel for this task. Another problem connected with chimney sweepers is that they have traditionally a monopoly in their district, but free market rules require an opening to competition. Therefore, the role of chimney sweepers and energy inspectors has to be committed by periodical open tenders.

Where inspectors are accredited as independent experts, the final impact is generally positive, even if in some cases complaints were received by the public authorities that the attitude of the inspector was too severe for minor infringements of the safety or efficiency rules, producing official letters reporting defaults and fines. The role of the inspector encompasses therefore the risk to be more a "policeman" than an advisor, reducing the potential of inspections for obtaining an actual energy efficiency improvement. It is recommended to train the inspectors so that they act as advisors and provide the most useful energy information to the users.

On the other hand, when the inspections are delegated to the service staff in charge of maintenance, the qualification and the capacity of providing recommendations is good, but the independence of inspections is questionable. Some MS have indicated the need for more objective methods for providing inspections, avoiding, for example, any bias in providing recommendations on efficiency improvements by service staff involved in installation services. To avoid or limit a non-independent issue of recommendations, some MS developed tools for an automatic generation of advice, based on the findings registered during inspection.

A specific situation regards A/C inspections. Every year, millions of new small air-conditioners are installed all over Europe, and units larger than 12 kW will have to undergo mandatory periodic inspections. Their inspection should provide the answer about its proper installation, as well as some guidelines for the end users about their management. However, most MS have no public registers of A/C systems, no obligation of regular maintenance, no checks made by public authorities on their efficient performance, except for the risk of leaks of polluting fluorinated gases. Therefore, the task imposed by Art. 9 of EPBD is particularly new and challenging; in most MS, little progress has been observed in this respect.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Boilers: Option A (Inspections) or Option B (Campaigns)?	Advice/information campaigns (Option B) have to be compared with proper inspections (Option A) on cost-effectiveness.	Combined solutions have been developed in more flexible approaches.	These combined solutions should be further studied in the near future. Examples of cost-effectiveness assessments have to be provided and discussed.
Drivers motivating voluntary inspections	MS have a multiple set of policies and programmes to improve substitution of old systems.	The elements of success have been identified and prioritised.	The quantification of the relevance of each driver requires data on impact evaluation. Impact assessment surveys should be implemented.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Training for inspectors	Possible development of a harmonised profile for boiler inspectors and common training features.	Not yet feasible.	When the inspection approaches become more similar, the circulation of experts could be a reasonable option.
The EN 15240 Standard for A/C inspections	Usability of the standard, role of national implementation in defining inspection classes, methods for determining efficiency have been discussed in detail.	The standard is useful, but several questions remain open, in terms of ambiguities, missing parts, points of questionable interpretation.	A quick revision of EN 15240 would be very useful.
Recommendations and interaction with energy certificates	The issuers and recipients are not always aware of the role and added value of certification and inspection.	Recommendations for heating/ cooling system efficiency improvements should be always included in the reports.	More effective information campaigns should be initiated by Member States.
Combining EPBD requirements with safety and CFC environmental regulations	The potential to make the coordination easier is large.	Several elements for coordination have been tested and referenced.	MS are invited to create connections in secondary legislation between actions related to EPBD inspections and CFC environmental control.
Improvement of inspection schemes in MS	Most MS are convinced that there is room for the improvement of their inspections scheme.	Areas of improvement have been detected: frequency of inspections, info to building owners, control system analysis, and cost-effective improvement.	Further work is required and concrete experiences are needed.
Boiler and Air Conditioning Databases	A database for boiler and A/C inspection reports has been established in a few MS.	Databases can: help compliance and control checks; assess boiler situation to draw new policies; allow users to compare their boiler "passport" with catalogues of more efficient boilers.	A better targeting of boiler and A/C databases is necessary, to justify the large effort required for creating them at regional or national level.
All season heating efficiency from inspection data	Several methods for the calculation of all-season system efficiency are available; a few of them can profit from data collected during inspection.	Include seasonal efficiency estimates in the formats for inspection reporting.	The new mandate to CEN should prepare a methodology tailored for a calculation method to be used by inspectors.
National approaches to fixing minimum EP requirements	Single product requirements fall under the Energy-related Product Directive, while whole buildings, and whole heating/cooling systems are covered by the EPBD.	Only a few MS have expressed minimum requirements on heating and cooling systems, and cost effectiveness analysis is often missing.	Heating and cooling system efficiency should be considered in MS minimum requirements; cost-effectiveness in fixing values must be taken into account.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Cost-effectiveness of A/C inspections	A stepped approach could provide a more cost-effective approach to A/C inspections.	The way explored by the IEE HARMONAC project was found to be an interesting option to implement.	Further analysis is needed in order to clarify the terms of actual implementation. The final results of the project HARMONAC should be explored.
Developments in A/C inspections in MS	The most advanced regulations on A/C inspections provide a pre-inspection phase, and recommendations on operation, improvement and replacement.	Considering the limited number of MS having produced suitable regulations, the topic is far from concluded.	When other MS issue regulations on A/C inspection, pre-inspection and recommendation topics will receive wider consideration.
Long-term automatic monitoring of heating & A/C systems	The benefits of monitoring energy consumption have been clearly demonstrated , using smart meters, data loggers connected to energy measuring sensors and B.E.M.S.	Early examples of smart meters capable of supplying energy data to end users and obligation to monitor energy consumption are already available. Further discussion is needed.	MS should ensure that utilities installing smart meters are obliged to supply energy data to the users . Forms of obligation to install energy meters on A/C systems should be experimented.
Interaction of inspectors with other market actors	Discussing the benefits of an interaction between inspections and other market actors, interest was raised in simplified tools for installers, based on inspection data.	Simplified tools for assessing efficiency of existing equipment and estimating benefits by substitution should be part of the inspection process.	The raised interest indicates that the topic needs further discussion, also in light of the EPBD Recast Directive.

5. Lessons learned and recommendations

Many Member States are still at an early stage in the implementation of their inspection approach, especially in relation to A/C systems.

Most chose mandatory inspections for heating and A/C systems. Nevertheless, there are still not sufficient data and studies to clearly define if advice/information campaigns (Option B) compared to proper inspections (Option A) are equally effective.

Combined solutions have also been developing, meaning that inspections or pre-inspections are accompanied by information campaign targeting users. An interesting shift has indeed been detected: from a rigid definition of the two approaches to a more flexible and combined approach, from an inspection aimed at controlling the systems to a combination of on-site visits, generation of advice, and informative supporting campaigns.

The situation could still evolve and change, as many countries are comparing their ideas with the new information obtained from experiences of other countries. A gradual convergence has been achieved since 2005, considering that, at the beginning of the CA EPBD, each country had different ideas about how to implement this requirement of the Directive.

To improve inspection schemes, a SWOT analysis was carried out. Current Inspection schemes present common strengths, weak points, as well as opportunities and threats:

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> • verification of actual status • concrete observation • creating awareness • provide figures from measurements 	<ul style="list-style-type: none"> • possible high cost • measuring equipment is required • skills are missing, even for advice
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> • the inspection should include advice to improve the system • a benchmarking with respect to best systems will be very effective • the inspection may create business 	<ul style="list-style-type: none"> • the application of the advice may not match the expectations • mistakes can occur with measurement and advice • inspections could be perceived as useless, or as a “fiscal” check • possible commercial exploitation

The lessons learned during the CA EPBD 2 can be summarised as follows:

- Inspections are a tool in a cluster of actions for reducing energy consumption and CO₂ emissions.
- The inspections must suggest energy efficiency improvements in the system being inspected; they should be combined with information and advice campaigns.
- Many Member States have opted for a combination of inspection and information to users, where the main difference is between mandatory and voluntary approach. Communication campaigns are no longer implemented in a conventional way, but combined with the promotion of voluntary inspections, check-up lists aimed at giving advice to end users, offer of small incentives, etc.
- It is not known to what extent training for basic skills for inspectors can be harmonised. Language differences are seen as a significant barrier to the circulation of experts. A harmonised profile for boiler inspectors is probably feasible over a long period, but not in the short term.

Important recommendations are already identified:

- On-site inspections should represent (at least for A/C systems) the last step in the framework of the so-called “graded inspection” scheme (pre-audit, audit, on-site inspection), expected to reach a higher level of cost-effectiveness.
- Maintenance data obtained from service personnel are useful and probably reliable enough for a pre-inspection phase. Energy consumption data could be used for benchmarking, both for heating and A/C systems.
- The on-site visit should sum up different checks: ventilation efficiency, fire risk and gas exhaust safety, CFC, EPC data collection, etc.
- As inspections are a good opportunity to give specific advice while visiting the end-user premises, the inspection report should address the non-technical final recipient:
 - It should be understandable for non-technicians (owners and tenants).
 - It should provide customised advice, suggesting cost-effective measures, mainly focused on low cost investments.
 - It should compare the actual performance with more energy efficient heating systems, and the existing system type with better technologies (renewable energies, co-generation).
- Member States should ensure that utilities, when installing smart meters, should be obliged to supply energy data to the users. Forms of legislative obligation to install energy meters on heating and A/C systems should be experimented.

Possible topics to be further investigated in the future include the following:

- Interaction between inspection and certification (producing an inspection report in combination with certification, using certification information at inspection and vice versa).
- Interaction with Eco-design of end products Directive (component characteristics and limits) and with Energy Services Directive, including cost-effective methods for identified optimum requirements for heating and cooling systems.
- In-depth analysis of the HARMONAC suggestion of a pre-audit methodology, connecting it with EN 15239, collecting A/C benchmarking values from different studies and methods, and comparing them with the actual building consumption data, as well as analysing the MS new Regulation texts for A/C inspections (some of them already adopting parts of the HARMONAC scheme);
- Analysing further simplified tools to assess actual and future (after substitution) all-season system efficiency.

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