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Inspection of Heating and Air-conditioning systems – Strategies for cost- effective implementation

January 2011



CONCERTED ACTION
ENERGY PERFORMANCE
OF BUILDINGS



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1 General Information

Articles 14 and 15 of the EPBD Recast (2010/31/EU) introduce on-site inspections of heating and air conditioning systems in order to “*maintain their correct adjustment in accordance with the product specification and in that way ensures optimal performance from an environmental, safety and energy point of view*”.

The EPBD Recast has extended the subject of inspections from the generator (boiler or air conditioner) to the whole heating and cooling system, has included in the report a section on recommendations for cost-effective improvements, has indicated that the recommendations should be “*based on a comparison of the energy performance of the system inspected with that of the best available feasible system and a system of similar type for which all relevant components achieve the level of energy performance required by the applicable legislation*”. Moreover, an independent control system of the inspection reports has to be set in place by Member States (MS).

The MS have transposed the EPBD inspection articles foreseen in the original EPBD (2002/91/EC) in different ways, but in all cases the difficulties in implementation have appeared much larger than expected, since for most MS there was no previous experience on system inspections for energy efficiency improvement.

EPBD Recast Article 14: Inspection of heating systems



1. Member States shall lay down the necessary measures to establish a regular inspection of the accessible parts of systems used for heating buildings, such as the heat generator, control system and circulation pump(s), with boilers of an effective rated output for space heating purposes of more than 20 kW. That inspection shall include an assessment of the boiler efficiency and the boiler sizing compared with the heating requirements of the building. The assessment of the boiler sizing does not have to be repeated as long as no changes were made to the heating system or as regards the heating requirements of the building in the meantime. Member States may reduce the frequency of such inspections or lighten them as appropriate, where an electronic monitoring and control system is in place.

¹ Recital 26 of the Recast Directive, reproduced in the box at the end of chapter 5.

2. Member States may set different inspection frequencies depending on the type and effective rated output of the heating system whilst taking into account the costs of the inspection of the heating system and the estimated energy cost savings that may result from the inspection.

*3. Heating systems with boilers of an effective rated output of more than 100 kW shall be inspected at least every two years.
For gas boilers, this period may be extended to four years.*

2 The difficulties

Any on-site inspection has an associated cost, and MS were reluctant to use public finances for this task unless it was clearly demonstrated to be economically justifiable. Furthermore, MS had reservations about further burden on consumers if the benefit was not readily justifiable.

Whoever is paying, the next difficulty is to identify a suitable category of possible inspectors: the service staff in charge of maintenance, the “chimney sweepers”, energy auditors, independent experts acting as consultants, etc.

The next problem is to allocate the responsibility of control to a truly independent and competent organisation.

Finally, determining the possible energy saving impact of an inspection system is not easy, consequently the cost effectiveness of inspections is still not clearly established across the full range of heating and cooling systems available on the market today.



EPBD Recast Article 15: Inspection of air-conditioning systems

1. Member States shall lay down the necessary measures to establish a regular inspection of the accessible parts of air-conditioning systems of an effective rated output of more than 12 kW. The inspection shall include an assessment of the air-conditioning efficiency and the sizing compared to the cooling requirements of the building. The assessment of the sizing does not have to be repeated as long as no changes were made to this air-conditioning system or as regards the cooling requirements of the building in the meantime.

Member States may reduce the frequency of such inspections or lighten them, as appropriate, where an electronic monitoring and control system is in place.

2. The Member States may set different inspection frequencies depending on the type and effective rated output of the air-conditioning system, whilst taking into account the costs of the inspection of the air-conditioning system and the estimated energy cost savings that may result from the inspection.

3. In laying down the measures referred to in paragraphs 1 and 2 of this Article, Member States shall, as far as is economically and technically feasible, ensure that inspections are carried out in accordance with the inspection of heating systems and other technical systems referred to in Article 14 of this Directive and the inspection of leakages referred to in Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases (1).

3 The merit of inspections

If all possible options for promoting improvements of energy efficiency in building systems are considered, including:

- information campaigns,
- delivery of individual advice by energy-info-centres,
- allocating incentives using public budget money,

- improving the qualifications of designers, installers and suppliers, by training them or providing some form of accreditation, and
- on-site checks and targeted advice by qualified staff (energy ambassadors or inspectors)

The latter appears to be the most successful. In fact, the final user likes specific suggestions for his/her own system, and is satisfied if the expert is able to explain what is most tailored to his/her system.

Several papers report evaluations on the provision of written² and tailored^{3,4,5} advice, in terms of statistical surveys able to define the percentage of users “set to action” and the percentage of influence of the tailored advice on the decision, in respect to all other influencing factors. Percentages as high as 40-46% of attributed influence of individual advice (particularly for heating systems) indicate a very powerful impact of this promotional tool (individual advice appears much less effective for renewable energy systems, where workshops, conference and fairs score better⁴).

Even if no evaluation campaign is yet available on inspections, their potential for setting final users to action can reasonably be expected to be quite high, provided that the inspector is actually able to provide valuable recommendations and does not limit himself/herself to just recommending the correct maintenance of the system.

4 The market scene

Considering this context, participants in the Concerted Action EPBD have studied how the inspections can interact with the most important market actors, who have some interest in maintenance, sales, information, advice, technical tests, consumer’s protection and similar. In fact, the Authorities delegated to the EPBD implementation can profit from their collaboration to get a stronger impact for improving energy efficiency in existing systems.

A tentative list of the market actors having an impact on inspections includes:

1. Chimney sweepers
2. Operation and Maintenance staff
3. Energy Auditors
4. HVAC Installers
5. HVAC Professionals (designers of systems)
6. Full-time inspectors (not involved in other professional tasks in HVAC)
7. Information Centres and advice services promoted by public or private organisations
8. Consumer Associations
9. SMEs, Craft Associations and their training bodies.

Their possible contribution to the effort for inducing an energy efficiency improvement in building heating and cooling systems was assessed on a case by case basis.

4.1 Chimney sweepers

The experience in adopting this category as boiler inspectors, for example in Austria and Germany, shows that they carry out good efficiency checks on boilers, but need a significant training and change of attitude before being charged with the task of recommending cost effective solutions for improved energy efficiency. Moreover, it has to be considered that they usually do not have any experience in air conditioning.

² M. Antinucci and C. Maby: Evaluation of Local Energy Agencies Performance, Proceedings of IEPEC Conference, Paris 2010.

³ Grégory Chédin: What Lesson Can We Draw About the Most Evaluated Programme in the Energy Efficiency Sector-The Local Energy Information Centres?, Proceedings of IEPEC Conference, Paris 2010.

⁴ Claire Murray, Energy Saving Trust, London, UK and Charles Michaelis, Databuild, Birmingham, UK: Evaluating support for local authorities to deliver sustainable communities, Proceedings of IEPEC Conference, Paris 2010.

⁵ Grégory Chédin, ADEME, Angers, France: What lessons can be drawn from the evaluation of energy advice centres?, personal communication.

Even if the inspection task is assigned to other types of experts, the interaction of the consumer with chimney sweepers is important, as they periodically visit the users, are trusted for their environmental and safety advice, and have a long term experience in the boiler technology. A training programme addressed to chimney sweepers seems very useful to help them to provide advice to the final users.

4.2 Operation and Maintenance (O&M) staff

The O&M staff of a heating or cooling service company is often affiliated with the manufacturer of the main equipment, but in other cases can service and maintain many brands, having experience on all of them. Members of the O&M staff periodically visit the facilities if there is a regular maintenance and control contract (for example for boilers in Italy or for large Air Conditioning systems in Cyprus), or intervene at the direct request of the client for a one-off visit; in any case they visit the customer premises and have the opportunity to provide advice; they have a sound technical background (or could easily improve it with a short training), are in general very happy to provide a more qualified service to their customers (even at low or zero added cost), as they could provide suggestions and offers for new equipment, directly or indirectly. The main objection is that O&M staff, particularly when they are affiliated to a single manufacturer, are naturally biased in the supplied recommendations, in view to favour specific technologies, components or suppliers, and consumer associations are particularly sensitive to this aspect. In fact, Art. 16 of the recast EPBD requires that inspections should be carried out in an independent manner by qualified and/or accredited experts.

Countries can set in action two complementary ways to guarantee the execution of inspections and the provision of recommendations in an independent manner: i) by organising an independent control system for the inspection reports of HVAC systems, under public responsibility, as specified in Annex II of the recast EPBD, and/or ii) by developing standardised methods, that “automatical” generate evaluations and recommendations, hindering the generation of biased recommendations, as they are independent from the operator applying them⁶.

The implementation of the inspection task by service staff requires a capacity building, particularly i) in understanding the methods for providing benchmarking and recommendations⁷, ii) in learning the use of the standardised tools, and iii) in getting awareness on the influence of the building envelope in determining the heat load. The last point is important to avoid that final users receive the wrong idea that saving energy is only a matter of system efficiency, disregarding the reduction of losses in the building fabric. For Air Conditioning systems there is an ever larger lack of experience in providing standard energy efficiency advice to final users, but an important source of information and experiences may be obtained through the Intelligent Energy Europe HARMONAC project, www.harmonac.info.

4.3 Energy auditors

Inspections are an important part of an energy audit of a building. The energy auditors have all the skills necessary for carrying out inspections and making system improvement recommendations. As the energy audit is an expensive task, it cannot be generalised for all buildings, usually remaining a voluntary practice. The system inspection is a minor part of the total cost, but as it is not necessarily cost effective to be performed alone by the energy auditor, it is best accomplished as part of the whole energy audit. In several Member States (Poland, Czech Republic, and others) the energy auditors are registered or accredited by the State, and may also officially operate as inspectors.

4.4 HVAC Installers⁸

Installers are a group of market actors having a direct interest in the renovation of HVAC systems. It is generally not recommended that installers operate directly as inspectors, as the final user has reservations in accepting any recommendation issued by this type of professional, who has obvious interests (to sell and install additional equipment). It is the responsibility of the final users or their consultant to contact installers to request offers for new equipment, but examples can also be found of

⁶ An example of a tool of this type was produced by SenterNovem in the Netherlands, for the voluntary check of systems where the boiler is older than 15 years.

⁷ The calculation tool developed by the IEE project BOILEFF is an example of independent system for presenting the benefit of the boiler replacement (BOILEFF, Intelligent Energy Europe – IEE project number EIE /06/134/sl2.448721, www.energyagency.at/boileff).

⁸ An experience where the role of providing advice is assigned to the installers is reported in the Intelligent Energy Europe – IEE project BOILEFF www.energyagency.at/boileff

installation companies offering a free energy audit to the administrators of multi-family buildings (condominiums) as a promotional initiative, as part of a complete package including a bank loan, a guarantee of performance and a third liability insurance.

4.5 HVAC Professionals (designers of systems)

In case of major improvement of the system (for example full replacement of the boiler house or A/C plant), the role of a system designer becomes essential to provide the user with a sufficiently accurate estimate of the investment. Here again it is the responsibility of the final user or their consultant to contact HVAC professionals to acquire a preliminary design with estimate of cost and, if approved, to commit the final design and work supervision. The preliminary service of the designer may also be offered free of cost in case of purchasing groups organised by consumer associations or local energy agencies, to provide an independent technical support to the group members.

4.6 Full-time inspectors (not involved in other professional tasks in HVAC)

The creation of a category of “pure” inspectors is at present quite rare. In principle, this new profession could be active in several checks and tests, to be performed at home (CFC gases, other environmental checks, safety issues, electric grounding test, and so on). This category is certainly fully independent, can sign a code of conduct with their associations or public bodies, be submitted to a compliance and control check, and use standardised tools for issuing technical advice. They may provide services at a legally fixed price (in this case the inspectors are accredited by the State or by a national agency) or operate under free-market conditions.

4.7 Information and advice centres.

In several countries, the State, the Region, or even the local administration, support, organise and coordinate information centres, which not only have the task of delivering information materials and general suggestions, but also of providing specific, target oriented, advice. Examples are the Local Energy Information Centres in France, financed by ADEME, or the Energy Advice Centres in UK, funded by the Energy Saving Trust. There is a risk that the inspection report could be in contrast with the output that the final user receives from these Info Centres, generating confusion and scepticism. A possible suggestion is to also involve the representatives of the Info Centres operating in the region in the regional “Steering Committee” on inspections, and develop common tools, or at least non-contradictory ones.

4.8 Consumer associations

Consumer associations are interested in verifying the “independent manner” required by the EPBD. Several ways to involve them could be proposed and/or piloted, although no experience is yet available. The creation of a regional “steering committee” including representatives of all types of market players, including consumer associations, could be the first step for promoting cooperation between all the parties.

4.9 SMEs, craft associations and their training bodies.

Entrepreneurial associations can be involved as previously proposed via:

- Participation in a regional Steering Committee on system inspection.
- Agreements with associations of inspectors for facilitating the acquisition of quotations for system improvement and renovation.
- Provision of training to their associates in Energy Efficiency and Renewable Energy Sources, including energy auditing and issue of information and advice.

5 Methodologies for inspections

Established within a mandate given to CEN by the European Commission, the standards EN 15378 “Heating Systems in Buildings - Inspection of boilers and heating systems” and EN 15240 “Ventilation of Buildings - Energy Performance of Buildings - Guidelines for inspection of air-conditioning systems” provide a list of items that should be checked during an inspection. The list is extensive, and in most cases too expensive to be adopted by MS for the purpose of inspection alone. There was some concern by Member States on the practical use of these standards, as they lack the kind of checks required by the Directive; for example an easy estimation of system energy efficiency, a quick assessment of correct sizing of the generators, the absence of indicators for benchmarking the performance of the system, etc.

For air conditioning systems, an important point is the widespread lack of an electrical sub-meter for the A/C system alone, while the central electric meter measures also artificial lighting, computers and other internal loads; this means that it is very difficult to determine an indicator of the actual energy consumption of the system.

Developments which have taken place in recent years have to be considered in the air conditioning field:

- the F-gas Directive⁹ has already created an accreditation for F-gas inspectors and a new log-book to register tests, having strong similarities with the requirements of the EPBD;
- an Information Paper deriving from the EPBD Concerted Action, published by the EPBD Buildings Platform¹⁰, suggests opportunities for coordination of the two control systems;
- the manufacturers of Air Conditioning systems developed commissioning formats for refrigeration technicians, requiring a set of simple measurements at the chiller outlets (pressures at evaporator and condenser, temperatures at compressor inlet and condenser outlet, absorbed electric power) allowing a calculation of the EER of the chiller, using software where the main chillers characteristics are included.



EPBD Recast, Recital (26):

«Regular maintenance and inspection of heating and air-conditioning systems by qualified personnel contributes to maintaining their correct adjustment in accordance with the product specification and in that way ensures optimal performance from an environmental, safety and energy point of view. An independent assessment of the entire heating and air-conditioning system should occur at regular intervals during its lifecycle in particular before its replacement or upgrading. In order to minimise the administrative burden on building owners and tenants, Member States should endeavour to combine inspections and certifications as far as possible.»

6 Experiences across Europe

A set of national, regional and local initiatives and measures have been collected in 2010. The experiences from these are reported here as they demonstrate possible cooperation initiatives between Inspections' Implementing Authorities and market actors.

Tools for providing recommendations

The national initiative called “Installation Performance Scan” in the Netherlands¹¹ started in 2005 for helping voluntary inspections implemented by maintenance engineers was applied to large domestic and non-domestic boilers, more than 15 years old, using a PC-based format for inspection (a check list), and another tool for the automatic generation of advice. The inspection is under responsibility of the professional and paid by the user. Its impact has been very positive and now the initiative is extended to non-residential buildings.

⁹ Regulation (EC) 842/2006 on certain fluorinated greenhouse gases, Regulation (EC) 1516/2007.

¹⁰ Jacqueline Hooijschuur - SENTERNOVEM (NL) , Hans-Olof Karlsson Hjorth - BOVERKET (SE), Olav Isachsen - NVE (N): EPBD Inspections - Possible coordination with fluorinated greenhouse gas-checks and other inspections, Publication 123, 12-09-2008, <http://www.buildup.eu/publications/1284>

¹¹ Installation Performance Scan, SenterNovem, The Netherlands.

IEE project HARMONAC

Another experience, described in the IEE project **HARMONAC**¹² concerns the inspection of Air Conditioning systems in buildings. The project provides a list of the diagnostics, possible solutions, and expected benefits. A gradual approach to inspections is proposed, where a pre-inspection phase is recommended, based on the analysis of energy consumption data, to assess the need of further on-site investigation. The actual inspection is then carried out only on the systems showing a significant need of further analysis, and if necessary will be followed by a detailed energy diagnosis. Based on the practical experience, the suggestions providing the largest energy benefits are related to control defects, unnecessary running of the equipment and badly chosen set points. An accurate and costly energy audit, requiring engineering skills, is recommended for very special cases only.

IEE project BOILEFF

The experience of the IEE project **BOILEFF**¹³ is also relevant, as the project partners have developed and tested a calculation tool for the definition of seasonal boiler efficiency for the situation before and after boiler replacement with high efficiency boilers. The results of calculation were compared with actual consumption data derived from measurement (metering) and found to be reliable within 3%, therefore recommended for performance guarantee contracts within that accuracy interval.

Maintenance staff controlled by inspectors

The regular inspection task is assigned to maintenance personnel, who regularly check boiler efficiency and report a format to the local authorities. They are requested to provide sample controls on paper and on site, and can impose sanctions if maintenance and control is omitted, or the system is performing inefficiently, not respecting the minimum requirements in force at the time of purchase. A few lines are available in the reporting format for notes and recommendations, but they are usually only filled in when safety requirements are not fully satisfied (see Slovenia for heating and cooling systems, Italy for boilers, Cyprus for air conditioning systems). The level of qualification of the maintenance personnel is high, as a lot of continuous training is provided by the SME associations and their training organisations. However, they are not trained for providing recommendations, and they should be strictly supervised to avoid biased suggestions to the end users.

To raise money for organising a compliance and control system, the public authorities may charge a small fee on each periodical boiler control, as was introduced in Italy in 2006.

Chimney sweepers and training needs

So called “chimney sweepers” operate in countries like Austria, Germany, Slovenia, Croatia, Hungary and other Central European States. They have a licence for a territory, are in charge of cleaning chimneys and boilers, but also have the task of verifying the correct combustion performance from an environmental and safety point of view. They normally measure the combustion efficiency of the boiler. In many cases training is provided to them to improve their capability of supplying correct advice on energy efficiency of the building. In Slovenia the chimney sweepers are accredited as inspectors by the Ministry of Economy.

There are no equivalent professionals, similar to chimney sweepers, for the maintenance and inspection of HVAC-systems.

State-licenced inspectors

For inspections in the framework of the EPBD, inspectors should obtain a licence from the competent authority, as is the case in e.g. Bulgaria and Slovenia. Therefore, cooperation is established in developing and implementing common training courses to re-qualify chimney sweepers, installers of solar thermal systems, and/or installers of biomass boilers into inspectors.

Incentive campaigns and inspections

The heating technicians provide advice about grants for replacing HVAC systems, given by the regional and national government in Spain, for installing renewable energy, boiler and air conditioning systems, and for replacement of windows with more efficient units (domestic and commercial use). Beneficiaries are ESCOs, private companies, public bodies and final users.

¹² HARMONAC, Intelligent Energy Europe - IEE project number EIE/07/132 www.harmonac.info

¹³ BOILEFF, Intelligent Energy Europe – IEE project number EISAV/EIE/06/134/2006 www.energyagency.at/boileff

Energy and climate voluntary advisors

Several types of professionals can perform inspections of HVAC-systems, like for example the energy and climate advisors in Sweden: the advantage they have is their connections with the end users, their independent role and experience in giving advice to end users, in a country having formally selected option B in article 8 of EPBD 2002/91/EC (now still allowed by point 4 of art. 14 and 15 of EPBD Recast). As the end users may not be interested in advice on Energy Efficiency and Renewables, it is vital that the advisors are well trained in giving advice and are service minded. As the end users feel that the maintenance staff who are responsible for periodical system control may be biased in their recommendations, the energy and climate advisors are better placed to provide a second step opinion and even participate in the inspection if necessary.

The National Energy Agencies, as responsible authority for inspections of heating systems, have performed various surveys in Nordic countries, to map out fossil fuelled heating systems. Information and guidance to the owner has been offered through the energy and climate advisors, in view of the national environmental objective to see the use of fossil fuel for heating of building getting to an end in 2020 (Sweden).

Professional air conditioning system inspections

For the air conditioning system inspection process, the inspectors should have a specific certificate of competence, as for example in France for cooling systems. There is a need for the appropriate training of suitable staff so as to meet the relevant criteria set out by the regulating authority and to become qualified as an inspector. Among others, the inspector should be capable of advising the users, if required, about the replacement of the system, necessary improvements of the cooling system or any other alternative solutions.

During the inspection of air conditioning systems, the following topics are considered as a minimum set:

- Assessment of elements influencing the system efficiency, like cleanness of filters, status of heat exchangers, regulation and controls.
- Assessment of system size in relation to the energy requirements of the building.
- Advice to the users, if required, about the replacement of the system, necessary improvements of the cooling system, correction of set points and time schedule for operation of fans and pumps, or any other alternative solution.



EPBD Recast Article 16: Reports on the inspection of heating and air-conditioning systems

“1. An inspection report shall be issued after each inspection of a heating or air-conditioning system. The inspection report shall contain the result of the inspection performed in accordance with Article 14 or 15 and include recommendations for the cost-effective improvement of the energy performance of the inspected system.

The recommendations may be based on a comparison of the energy performance of the system inspected with that of the best available feasible system and a system of similar type for which all relevant components achieve the level of energy performance required by the applicable legislation.”

7 Discussion

The criteria to use for selecting an inspection strategy can be considered as:

1. Effectiveness in promoting energy efficiency improvements.
2. Cost effectiveness for both the public budget and for consumers.
3. Level of independence in providing the advice.

According to the first criterion, skilled energy consultants are clearly preferable, as for example the energy auditors, officially accredited in several MS, or energy designers and other private consultants. Of course, they have to be paid by the final user based on market price, therefore usually they are suitable only for voluntary schemes, because they are expensive.

From the point of view of cost effectiveness, the use of maintenance staff is clearly preferable, and systems have been developed to raise financial resources for setting up a control system to verify compliance of their work. The weak point in this case is the level of independence in providing advice and the need for training to provide quality advice for whole system/building improvement.

Using chimney sweepers apparently solves both problems of cost effectiveness and independence, but their capacity in providing advice for the whole system/building is apparently quite low.

According to the third criterion, independent operators, as for example the energy and climate advisors, should be preferable. The difficulty is that they obviously need a sufficient volume of activity to remain independent advisors and not to be linked to private interests (equipment suppliers, for example).

The final decision is therefore influenced by the priorities of the public authority in charge, depending on their energy policy, financial conditions, and willingness to impose costs to citizens for energy benefits. In any case, a well-designed inspection strategy has to carefully address its objective, and verify the cost effectiveness of reaching it. A simple check of regular maintenance operations may be an initial target when in a country there is not yet a habit of periodical control of boilers and A/C systems, but becomes insufficient if a more stringent policy is issued towards deep cuts of greenhouse gas emissions.

8 Conclusions

This report compares different inspection approaches, commenting on their pros and cons. The discussion indicates that **a decision on the best approach to inspections has to be taken carefully considering the energy policy objectives and the priorities in the criteria to be observed: effectiveness in providing advice, cost effectiveness and level of independence.** The experiences described in the text provide useful hints on the application of the various approaches, and the list of the market actors suggests their possible interactions with inspectors, in order to obtain a more effective impact in improving operation, producing improvements and accelerating substitution of old, inefficient equipment.

The exchange of experiences between the representatives of the bodies responsible for inspection implementation will continue in the next years in the frame of the EPBD Concerted Action, also in view of the new requirements on inspections imposed by the EPBD Recast, and will surely provide useful hints for a better matching of the various criteria proposed in this paper.

This report is funded by the Community's Intelligent Energy Europe programme under the contract IEE/CA/07/333



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