Global improvements of the energy efficiency of the European air conditioning stock: results from AuditAC project.

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SUMMARY

Following the continuous growth of the air conditioning market and the European Directive on the energy performance of buildings (EPBD), many changes are expected on the European air-conditioning market. The article 9 of the EPBD takes care about the Inspection of air-conditioning systems promoting possible improvement or replacement of the air-conditioning system. The AuditAC project reached its conclusion with a set of deliverables showing: the advantages from the new inspection system, how to benefit from the combination of air-conditioning (AC) systems audit and inspection, to promote the best practices and to help harmonising the implementation all over the European countries. The results are delivered in form of tools and guides freely accessible from the AuditAC web site. Ten technical guides and tools for owners, energy managers and auditors have been delivered with the aim to rise the awareness of the users about the energy savings subsequent to a “wise” management of the air-conditioning plant, to discover the energy conservation opportunities of an air conditioned building from a full list of possibilities, guiding auditors in audit procedures and supplying advices to identify the actual system performances and forecast energy savings.

INTRODUCTION

In the coming years the stock of Air Conditioning (AC) equipment in use in Europe will partly become obsolete. Most systems will be renovated for the first time (after 10-15 years of operation) and an opportunity exists to introduce higher efficiency systems. Out of the 2.200 Mm² of air-conditioned building area in use in 2010 in Europe, 800 Mm² will date by more than 15 years and will need urgent renewal (Figure 1). A SAVE Study [1] had the result that there is an energy saving of about 50 %. That means: AC – Systems are able to operate with about 50 % less energy.
This market will be influenced by the Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (EPBD [2]). According this new directive all over Europe, the building legislation will be changed to create higher energy efficiency within the European buildings.

The Directive takes care about the Inspection of air-conditioning systems:

**Article 9 - Inspection of air-conditioning systems**

With regard to reducing energy consumption and limiting carbon dioxide emissions, Member States shall lay down the necessary measures to establish a regular inspection of air conditioning systems of an effective rated output of more than 12 kW. This inspection shall include an assessment of the air-conditioning efficiency and the sizing compared to the cooling requirements of the building. Appropriate advice shall be provided to the users on possible improvement or replacement of the air-conditioning system and on alternative solutions.

AuditAC [3] is the short name for the two years project about “Field benchmarking and Market development for Audit methods in Air Conditioning”, completed in December 2006. AuditAC was not a project about the implementation of Article 9 of the EPBD. It was much more a project about the questions that comes after the legislation on the national level. Within the focus of AuditAC was to support the European AC market to reach higher efficiency, by taking benefit of good inspections and subsequent audit.

Inspectors or auditors are external or internal engineers (or qualified technicians) in charge of establishing the status and proposing improvements on a plant which is not in failure mode. This is true for Air Conditioning as for any other piece of equipment. In case of failure, a maintainer should be called, not an auditor…Inspection or audit should be the initial stage of any of the following actions: starting or restarting operation of a plant, energy efficiency improvement, study of possible renovation, etc. The owner that decides to go through various stages to reach Energy Efficiency looks for answers to which only the audit procedure can answer: is there an opportunity? How large could be the benefit and the cost of my action? How make the best decision between several possibilities? How check that the measure is effective? AuditAC wants to supply the tools and help to best answer to these questions and make the owner confident facing the investment for energy efficiency.

**AIR CONDITIONING ACTORS: HOW TO PROMOTE ENERGY EFFICIENCY**

The initial review of existing pre audit and audit methods for air conditioning systems proved they were very scarce. A number of measures in the EPBD do not benefit from experience.
feedback, among which the AC plants inspection. Inspection can be considered as a sort of short compulsory audit.

Audit behind inspection has been saw as a sporadically measure, although it should be repeated all along the plant lifetime in a continuous improvement strategy. Nowadays, there is always a factor giving birth to an audit. In the normal life of the plant it can only be a significant failure. For most plants an audit will only take place if the building suffers a deep renovation or ownership change. We see immediately that EU inspection from EPBD aims at introducing more audit opportunities.

If we look at the actors involved in the audit (Figure 2), only the owner or the manager is responsible for the decision but he rarely has the elements for the decision. These elements came from the auditor/inspector after exchanged information with all the other actors. Normally operators and maintainer do not have interest in the energy efficiency (except for specific O&M contracts). Finally best audit is a synergy from the different parts.

![Figure 2 Actors and relationships in a situation of AC audit](Figure2.png)

So firstly, the AuditAC objectives were to disseminate information about the new measures and to raise the awareness of the AC actors about the benefits of the audit. A set of deliverables in form of technical guides explains which are the key points of energy efficiency in an AC plant (TG 1: Are you sure you are not paying for inefficient cooling?), makes light on the new inspection systems (TG 2: Energy Auditing of Air Conditioning Systems and the Energy Performance in Buildings Directive: what does the new regulation say?) and makes the owners more familiar with the AC aspects: equipments and comfort requirements (TG 3: System recognition guideline for field visit).

A training package (TP) including the information of the project results has been released in order to promote the AC audit. This TP contains 150 slides made in simple and non-technical language, an open version is proposed to users who want to take inspiration and ideas for their presentation and training. A default version is proposed to the large public (Figure 3): it starts from the basic of the air conditioning and the systems summary, then go through the inspection measures and finally through the air conditioning audit and the energy conservation opportunities. The training package has been tested initially internally to the group and published at the end if the project after validation.
Furthermore, AUDIBAC interface (Figure 4) allows to retrieve in the AuditAC case studies database the cases that fit more to real problem starting from simple parameters choice (system type, sector building etc.): it is a real shop window for the air conditioning audit! In simple layout the TG 10 documents includes all the AuditAC successful case studies of audited of AC buildings in a simple brochure.

Figure 4 AUDIBAC database screen capture

All these documents are aimed to remove the prejudices of the owners about the air conditioning and rise the awareness of the opportunities to better operation of the systems maintaining or improving the comfort aspects. To improve the knowledge of the air conditioning is a first way to eliminate the barriers to the audit.

THE AUDIT PROCEDURES

In a second phase of the project we focused on the formal presentation of the characteristics of the procedures and the development of the procedures themselves. We made distinction between two levels of audit.
PRE-AUDIT

Pre-audit is a preliminary procedure mainly consisting in: inventory of thermal equipment in place and documentation, treatment of electricity consumption bills, disaggregation of AC data from others. We have found no existing real tool for pre-audit of air conditioning, except some check lists, outdated in some cases or mainly adapted to US practice. That led us to the definition within Auditac of a pre-audit procedure for air-conditioned buildings to support the pre-audit process (TG 4).

The procedure should preliminary investigate the possible of energy conservation opportunities (ECOs): we propose a full list of ECOs including actions at different levels: improvement through actions on Envelope and Loads, improvement through O&M, improvement through Building Energy Management System (BEMS), performance enhancement through adequate improvement works. Energy managers and owners can help the procedure with a continuous follow up of their consumptions and bills. TG 7 propose some simplified methodologies for non professional auditors to observe and track the AC operation and efficiency through the analysis of bills and consumptions: where auditor already find the owner doing a track of its consumption he will not need to do it again. A simple spreadsheet calculator tool, called AC-cost, allow to have a first savings estimation due to four common actions in term of money savings based on real or estimated running costs. The sheet is easy to use; it helps the user to estimate the requested information when unknown and its results are easy to understand as they are showed in form of cost savings in euros, as gain of annual running cost and payback times in years.

The Customer advising tool (CAT) (Figure 5) allows to rapidly observe the effect of actions on the existing envelope, taking into account the building structure and location, a link allow simply to explore existing audit case in the database AUDIBAC.

Figure 5 CAT tool screen capture

AUDIT

Thanks to the work on pre-audit, we may enter the audit phase going deeper in the selected ECOs in the previous procedure. There are tools to support the detailed audit of heating
plants. We have found no specific tool for auditing air conditioning. Audit duration is a cost issue: more and simpler are the auditor tools, shorter and more efficient would be the audit. In this sense, we proposed several tools to help the auditor in the unfortunate audit work!

The AuditAC-EES model (Simplified load calculation tool defining the consumption of ideal system with the same comfort demands) will lead the auditor to estimate consumptions and the impact of the retained ECOs through the introduction of few parameters from the audited building (Figure 6). The AuditAC-EES model is accompanied by its explaining user’s guide.

Figure 6 Inputs, parameters and outputs of the EES model

More help can come from the Eurovent-Certification database created in the AuditAC project. This database includes the Eurovent certified directories from 1995 until 2006 (an example in Figure 7). This directories includes certified values of performance for AC conditioners, auditor can retrieve data on the installed equipment when this is unknown, or retrieve data on the equipment of the same period and compare with performances of recent model and technologies looking for a better solution of replacement. How to benefit from this database is illustrated in the TG 6 “How to benefit from the Eurovent-Certification database and to retrieve past equipment data in the audit process”.

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The auditor should find less barriers as possible during the procedure: the TG 8 “How manufacturers could help the unfortunate energy auditor”, intended to manufacturers, explains how a component can be used as measuring device is an inexpensive way just adding measurement points in catalogues and how they can help audit improving the documentation of the equipment and their nomenclature. TG 10 and the AUDIBAC tool can one more time support the decision of the auditor to investigate some opportunities on the base of the previous successful case study presented in the database.

**ECONOMICS OF RENOVATION AND INSPECTION**

When does decision take place? Saving running costs, reliability, what are the decision factors? How to give an energy efficiency orientation to the renovation of AC? The new factor is the EU inspection: the ways to implement it have been investigated. How to integrate it in the life cycle of a plant? TG 9 “How to integrate Energy Efficiency and AC inspection with full benefit in the structures in place” explores the relations between the AC actors and defines the different interests and how to combine it in the effort for the energy efficiency. The aspects of certification and training of inspectors are faced, showing the possibilities in some country. Discussion about inspection has been animated also grace to the estimation of the energy and economic saving of the inspection implementation in main EU AC market countries: figures for an engineer and a craftsman inspection has been presented in many international meeting arousing a new discussions and interest.

**DISSEMINATION ACTIVITIES**

All along the project the group developed dissemination activities at international and national level. On one hand we combine internal workshops with open national dissemination meeting with professionals of the host country: this allowed us to meet national problems and situations peculiar for each country and to add on the view point of the professional (installers, manufacturers, operators etc). This allowed also to have a more clear idea of the
level of dissemination of the new inspection and certification measures in countries were the measures are not yet applied (no country implemented the AC inspection measures in the 2006, all asked for three years of delay).

On the other hand the group met an international public participating actively to international events and conferences, promoting results and tools all along their development (AICARR congress 2006, ICEEB 06, Klimaforum’06 etc.).

All the presented papers and posters are available on the AuditAC project web site and can be freely downloaded. The group was in charge to deliver also periodically a newsletter (6 in total all along the project) about the development of the project and about the Directive implementation, author outside the project has been invited to cooperate and intervene about EPBD or other EU project EPBD related. Each country was responsible to create a contact list and deliver the newsletter to the national list.

**CONCLUSIONS**

AuditAC was part of the IEE projects to support the EPBD implementation and success. The objectives more than support the inspection were to develop the audit procedures for the AC, due to the lack of methodologies and tools. On one hand several tools and actions has been prepared to reduce the barriers to the audit promoting successful Case studies of AC audit and disseminating the contents of the audit procedures in order to motivate the owners and manager to face the investment for the AC renovation for energy efficiency. Moreover, a series of tool wants to help the auditor into the procedure to make shorter and efficient the procedure. Deliverables in form of document (Technical guides for owner and auditors), programmes (Tools), disseminating tools (Training Package). The material is freely downloadable on the project site that will be kept operative for two more years after the end of the project (December 2006).

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